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Demonstrations in petrogenesis from Kiloran Bay, Colonsay.

I. The transfusion of quartzite.

(With Plates XI and XII.)

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With analyses by Agnes Gibbs and others.

[Read November 5, 1936.]

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1. Introduction.

In 1911 Dr. W. B. Wright[1] briefly described the felspathized quartzite blocks in the hornblendite of Port Easdale, Kiloran Bay, Colonsay, Hebrides. He showed that the exposures provide a conclusive demonstration that the action of hornblendite magma on quartzite xenoliths was to convert them to alkali-felspar and quartz, so that

[1] W. B. Wright and E. B. Bailey, The geology of Colonsay. Mem. Geol. Surv. Scotland, 1911, p. 29.

in the final stage 'one can recognize in numerous angular and round patches of felspathic material, without visible xenolithic core, t ghosts of former masses of quartzite'.

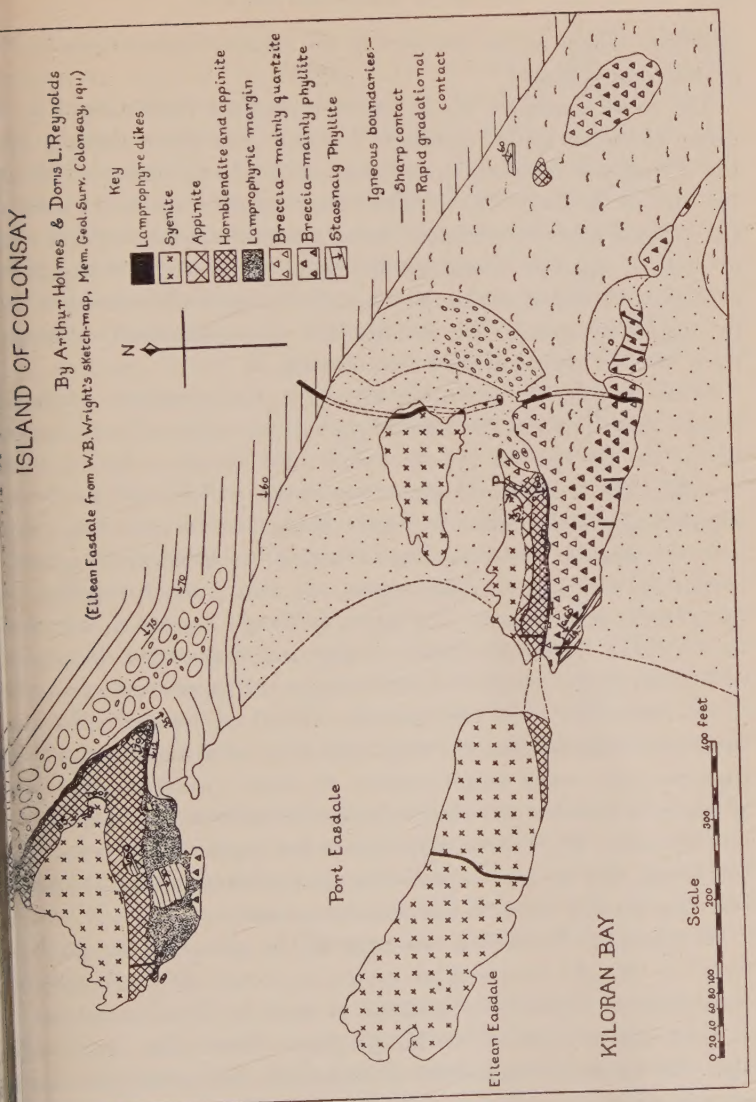
Twenty-five years have elapsed since the publication of Dr. Wrigh account, yet the importance of the record appears to have passed u noticed. The purpose of this paper is, therefore, to recall the occu rence; to amplify Dr. Wright's description with additional observatio and petrological and chemical detail; and to emphasize the pet logical significance.

Stimulated by Dr. Wright's description, Dr. Holmes and I paid preliminary visit to Colonsay in 1934. Finding much of interest returned in 1936 and, in order that no detail should be overlook remapped the small intrusions of Port Easdale on the scale of 54 inc to the mile. For this purpose the coastline, with its disconnec rocky outcrops, had to be remapped. As a result of our visits mu additional evidence of first-class petrological importance has b obtained. We propose to deal with this evidence in a series of pap of which the present communication, restricted to the phenom attending the transfusion of quartzite, forms the first.

2. Geological Setting.

The sedimentary rocks, which constitute the major part of island of Colonsay, consist of a folded, crumpled, and cleaved se of phyllites, limestone, mudstones, grits, and conglomerates, regar by Wright and Bailey as of Torridonian age. Kiloran Bay brea and occupies the centre of a structural basin in this series, the sh of the bay being margined by the Staosnaig phyllites, the youn beds of the succession. The latter are in turn margined by Colonsay limestone and successively older members of the sedim tary sequence.

On the northern shore of Kiloran Bay the Staosnaig phyllites pierced by three small composite intrusions consisting of hornblen appinite, and syenite. Two of these form the northern and south shores of Port Easdale, whilst the third outcrops in the higher gro directly to the north. Each of the three intrusions comprises elongated mass of syenite, trending in a W.–E. or NW.–SE. di tion, together with marginal phases of hornblendite and appi (hornblende and alkali-felspar). Further, the marginal phase each intrusion contain abundant angular and rounded block



B. 1. Geological map of the intrusions of Port Easdale. The strike lines of taosnaig phyllites are diagrammatic, except where observations of dip are ded. The arrows on the igneous types and on the breccia refer to the dip e contact planes. P indicates the locality of the syntectic pegmatite veins I, fig. 4).

quartzite which are to be seen in all stages of conversion to b syenite and appinite.

The most southerly of the three intrusions throws light on origin of the xenolithic quartzite blocks. Only the southern limb this intrusion is exposed, its northern margin being concealed bene the sand of the bay. The intrusion is elongated from west to east a the exposed portion consists of successive zones, from north to sou of syenite, appinite, hornblendite (showing gradations to appin throughout its mass), lamprophyre, and sedimentary breccia (develo by magma pressure). The distribution and ascertained relations these various types are shown on text-fig. 1.

In the present connexion the breccia is of importance. It show sharp contact against the Staosnaig phyllites and is as much an int sion as are the igneous types. At its outer margin, where it adj the phyllites, it is formed almost completely of closely interlock angular blocks of similar phyllite. A few feet in from the mar however, angular and occasional rounded blocks of white quartz sometimes two feet or more across, are also present, together v rarer blocks of limestone. The latter, as Wright suggested, is prob the Colonsay limestone which margins and dips under the phyl of Kiloran Bay. Away from the margin the proportion of quart blocks increases until the igneous contact is reached. There breccia is composed almost completely of rounded and angular blo together with much larger masses, of white quartzite. The la measurable in yards, are obviously representatives of a massive qu zite horizon. The blocks vary from a few inches up to two or t feet across, and the proportion of rounded relative to angular mem increases greatly towards the igneous contact.

No quartzite formation outcrops in the island, although it noted by Wright that similar quartzite occurs as small pebbl conglomerate beds at two horizons in the local Torridonian and as xenoliths in some of the lamprophyre dikes. The facts ind that the quartzite represents a formation older than the exp country-rocks.

That the breccia results from magma pressure is evidenced b restriction to the igneous margin. That it represents upheav evidenced (*a*) by the dip of the contact plane against the ph (text-fig. 1), and (*b*) by the disposition of the rock types withi breccia, the oldest variety occurring in contact with the ig rocks.

It remains to account for the rounding of some of the quartzite ocks in the breccia. So striking is this rounding that Wright was d to regard the blocks as water-worn boulders, derived from a ose surface formation, which had fallen into a fissure or pipe. r. Holmes and I discovered, however, that many of the boulder-ke forms in the breccia have pink felspathic rims, sometimes two or ree inches broad, similar to those of the xenolithic quartzite blocks the hornblendite and appinite of the intrusion. The inference is at the rounded blocks in the breccia have undergone a form of agmatic attack similar to that experienced by the xenoliths in the sic magma. It will be shown later in the paper that felspathic aterial developed from the quartzite may become palingenetic agma. If this occurred in the breccia, under conditions of high ress, mobile material formed around the periphery of the blocks ould readily squeeze away, and rounded forms would result. It ems probable that the quartzite blocks thus attacked were once rectly in contact with the hornblendite magma. Indeed, the horn-lendite is still roofed, at one point along the contact, by a slab of artzite, about one foot thick, which is margined against the horn-endite by a felspathic layer two or three inches thick. The fact that few rounded forms occur towards the outer margin of the breccia ay be accounted for by the greater ease with which such bodies, ossibly lubricated by magmatic material, could slip through the aving mass.

The massive quartzite adjoining the igneous intrusion at its eastern rtremity has the appearance of being turned up on edge, as though nched upward by the rising intrusion. This, together with the in-usive contact exhibited between the breccia and the Staosnaig ayllites, is indicative of the enormous upward pressure exerted by e rising magma.

Further evidence of magma pressure is obtainable from the intru-on which margins the northern shore of Port Easdale. Here the vaded phyllites have been forced outwards, as is evidenced by the rve of the strike lines round the intrusion (text-fig. 1). Both e northern and southern limbs of the intrusion are exposed in this se, and breccia is seen to be developed only on the southern margin. e breccia, moreover, consists of fragments of phyllite only.

3. Field Description.

(*a*) *Metasomatized Quartzite Xenoliths.*

In all three intrusions the major part of the hornblendite ar appinite is thickly sprinkled with blocks of white quartzite simil to that in the breccia which margins the southern intrusion. T largest blocks, which are up to two and a half feet long, are frequent of roughly rectangular form, whilst the smaller examples are usual rounded.

In the southern intrusion the quartzite xenoliths are fairly even distributed through the exposed portions of the hornblendite a appinite. In the hornblendite cliffs to the north of Port Easda however, there is some evidence that they are concentrated in t upper part of the intrusion, since a level charged with quartz blocks passes downwards to one which is almost free from such clusions. The distribution is, however, by no means uniform, patches of hornblendite free from such inclusions, sometimes six f or more across, are surrounded by zones heavily charged with xe liths.

Whereas a few of the quartzite xenoliths in the upper part of t intrusion are unaltered, the great majority are in some degree chang to syenite or appinite (pl. xi, fig. 1). The varied appearances wh they present are as follows:

1. In the apparently less altered xenoliths a core of white quartz is sharply margined by a narrow felspathic rim, up to 1 cm. in wid The latter, which is usually pink, but locally white, may be qu free from ferromagnesian minerals or may contain sparse sm crystals of hornblende. Where it adjoins the quartzite, the felspat rim commonly becomes rich in mafic minerals. This melanocra zone is extremely narrow, generally being 1 or 2 mm. across occasionally swelling out to 5 mm. Blebs of quartz are sometim visible in the felspathic rim.

2. More completely replaced xenoliths sometimes exhibit a cor quartzite surrounded by a narrow inner felspathic zone, like that j described, and a broad outer zone of appinite or syenite. There sharp boundary between the quartzite core and the felspathic rim, between the latter and the appinite or syenite. In the outer zone hornblende is frequently blade-like and occasionally, in zones appinite, it reaches a length of 6 cm., thus contrasting strongly v the stumpy prismatic hornblende of the hornblendite (text-fig. 2).

3. In other examples, a quartzite core is directly surrounded and arply bounded by a rim of appinite or syenite without the inter-ening felspathic zone. In such cases the hornblende is evenly distri-uted throughout the felspathized region. The percentage of hornblende aries, however, from one example to another, and in the more leuco-atic varieties of syenite it is absent, chlorite being the characteristic afic mineral.

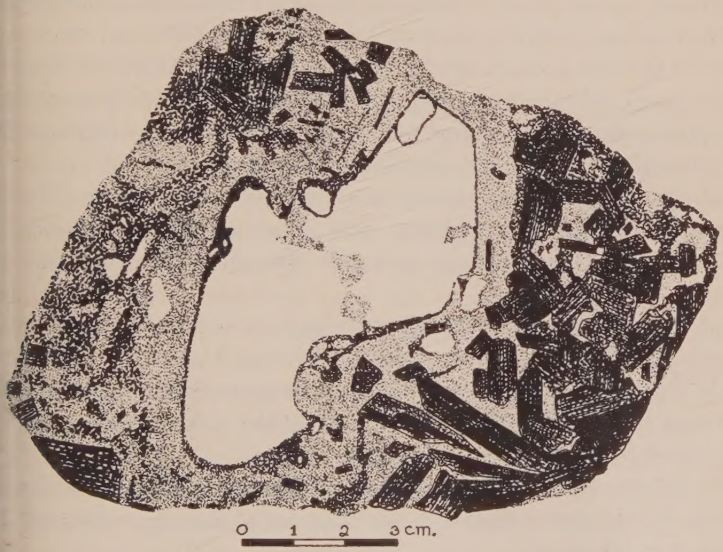


FIG. 2. Metasomatized quartzite xenolith, described in the text under type 2. narrow mafic zone, which adjoins the residual quartzite, is followed succes-ely outwards by a pink felspathic zone and an appinitic zone.

4. Many of the xenoliths have been completely replaced by appinite syenite. Leading up to this type there are examples in which small lated relics of quartzite still remain; the latter are surrounded by ngated hornblendes with a stellate arrangement.

Whatever form the replacement may take, one of the most striking enomena in the metasomatized quartzite xenoliths is the invariable rpness of the contact between the residual quartzite and its meta-natized portion. Moreover, where the quartzite core is surrounded two successive zones (type 2 above) the boundary between these lso sharp. If seen on a large scale in the field such boundaries uld inevitably be interpreted as intrusive contacts. From the well-ined replacement rim lobe-like forms composed of felspar frequently

penetrate the quartzite. Again, sharp contacts are seen, although t blunt endings of the vein-like projections testify to the replaceme origin of the latter.

Such sharp boundaries are at first surprising. Reference to expe mental work on replacement structures in metals, however, sho that actually they are to be expected when replacement results fro compound formation dependent on diffusion through a solid. Accordi to Desch,[1] in the study of diffusion in metals it has been found tha 'When an intermetallic compound is formed by diffusion, the bou dary of the new phase is perfectly sharp, and such sharpness may taken as an indication of compound formation.' In the present ca the development of the compound felspar results from the introducti of potassium, sodium, and aluminium into quartzite.

Although the metasomatized xenoliths present so many differe appearances, yet the following facts, relating to the diffusion felspar-forming and cafemic materials into the quartzite, stand o clearly.

(*a*) Felspar-forming materials only have in some cases been int duced into the xenoliths, as evidenced by type 1 above.

(*b*) Felspar-forming materials have in some cases advanced a sh distance farther into the xenoliths than the cafemic materials, evidenced by types 1 and 2 above.

(*c*) Felspar-forming and cafemic materials have in some ca advanced the same distance into the xenoliths, as evidenced types 3 and 4 above.

(*d*) Ferromagnesian minerals, within a felspathic zone, sometim form a narrow green rim against quartzite, but are separated fr the main hornblende-bearing region by a felspathic rim. This exemplified in some of the cases described as types 1 and 2 above

(*e*) Ferromagnesian minerals have in no case been introduced i the xenoliths beyond the limit of felspathization.

These facts appear to indicate that the process of metasomati takes place in two successive, but overlapping, stages: (1) introdu tion of felspar-forming materials, (2) introduction of cafemic materi for forming ferromagnesian minerals. Case (*c*) suggests that a cert amount of ferromagnesian material may travel with the vanguard potassium, sodium, and aluminium, the main introduction of cafe material following slightly later.

Against the enclosing rock the boundaries of the metasomati

[1] C. H. Desch, The chemistry of solids. 1934, p. 112.

noliths may be sharp (as is invariably the case in type 1), ill-fined, or merging. In the last case the original quartzite xeno-hs are now represented by felspathic patches or schlieren. Where e hornblendite is free from xenoliths it is also free from felspar, but the neighbourhood of felspathized quartzite blocks it becomes fels-thic and is then better termed appinite. Similarly, where appinite the enclosing rock it becomes more felspathic around felspathized artzite xenoliths and approaches syenite.

Syntectic Veins.

Some of the felspathized quartzite xenoliths have meteor-like tails felspathic material which pass out from the metasomatized blocks various directions through the hornblendite. In some cases these ails' are broad and short, whilst in others they are vein-like in their portions, being many yards long, although they may be less than inch wide (pl. xi, fig. 2). The appearance indicates that the spathic material, resulting from the metasomatism of quartzite, s in these cases become magmatic. At one point, near the seaward l of the southern limb of the intrusion margining the northern re of Port Easdale, such felspathic material is locally so abundant it cuts the hornblendite in a roughly rectangular network of ns (pl. xi, fig. 3). Indeed, the hornblendite now appears as rounded lusions in a pink felspathic matrix. Without the evidence of complete exposure, this small portion would hardly fail to be rpreted as resulting from the invasion of solid hornblendite by spathic magma. The appearance is reminiscent of the Arran gabbro-nite complexes; the dolerites veined with granophyre in Ardna-rohan; the hornblendite veined with leucocratic material on abal hill; and the peridotite veined with felspathic material at knafoyle, in the Newry complex. Yet here, in Colonsay, there is clusive evidence that the hornblendite magma itself generated such material from sediment. The vein material was in fact syntectic ma.

he roughly rectangular character of the vein network suggests the felspathic material migrated along the contraction joints in hornblendite, indicating that the felsic syntectic magma had a r crystallization temperature than the hornblendite magma.

t the extreme eastern end of the intrusion to the south of Port lale, the hornblendite is seen for two or three feet in vertical act with quartzite. Along the contact the quartzite is felspathized

in an irregular zone which has a maximum width of about two inch From this felspathic margin several veins of pink pegmatite exte into the hornblendite and beyond it into the appinite (pl. xi, fig. The veins, which are about 6 or 8 inches wide, have, in places, ir gular margins against the hornblendite. The irregularities are se to result from a certain amount of mixing of the two types. One ve in particular has a highly irregular upper margin above which t hornblendite, for a distance of several inches, contains small patc or blebs of pink felspar. The heterogeneous appearance is reminisce of an emulsion in which the felspar forms the disperse phase. T facts indicate that the syntectic pegmatite veins were injected ir the hornblendite whilst the latter was still fluid, and that blebs of t felspathic magma began to rise up through the hornblendite magn Lack of complete mixing, evidenced by the emulsion-like structu is suggestive of high viscosity. Around the felspathic patches th are blade-like crystals of hornblende sometimes several centimet long.

4. Petrology.

(*a*) *Hornblendite.*

Where free from inclusions of quartzite, the hornblendite is medium-grained dark-green rock consisting essentially of stun euhedral to subhedral crystals of amphibole which average ab 4 to 5 mm. in length. In thin section the amphibole crystals found to be composite, in that they consist of several varieties wh are associated both in zonal fashion and as replacements one of other. The optical characters of the varieties are set out in table

Table I. Optical data of amphiboles in the hornblendite.

	γ'.	$\gamma-\alpha$.	$\gamma:c$.	2V.
Brownish-green hornblende ...	1·657	0·019	20°	
↓				
Green hornblende	1·643	0·020	18°	Negative and c to 90° throu out.
Actinolite	1·638	0·025	18°	
↓				
Tremolite	1·634	0·027	15°	

The limit of error of γ', measured on cleavage flakes, is $\pm 0{\cdot}002$, except in case of tremolite for which γ' is correct to the third place. $\gamma-\alpha$ was de mined with a Berek compensator.

The central part of the crystals, which is brownish-green hornble with γ green $>\beta$ brownish-green $>\alpha$ pale brownish-green, me outwards in a very irregular but gradual manner to a green vari

ne latter may closely resemble the brownish hornblende in its ptical characters, but where zoning is most conspicuous $\gamma : c$ de- eases outwards to 18° at the margin of the crystal, there being a ncomitant increase in birefringence and decrease in refractive dices. The optical characters appear to indicate gradation to an tinolitic hornblende. The irregular form of the zones, which are t always bounded by crystallographic planes, possibly indicates at each zone is in part a replacement of earlier amphibole.

These crystals are usually terminated by outgrowths of tremolite, of pale actinolite followed outwards by tremolite. In some amples there is a complete outer zone of tremolite which is very rrow in the prism zone, often barely visible, and of considerable tent on the terminal faces. The outgrowths of tremolite, or of tinolite and tremolite, are sharply separated along crystallographic nes from the rest of the crystal. Where both varieties are present, ey, in turn, may be sharply bounded one against the other, or they ay show rapid gradation.

Commonly there has been replacement of the zoned hornblende by emolite. The latter, in such cases, embays the margins of the phibole and also occurs in irregular areas within it (pl. XII, 1). Tremolite also replaces the hornblende either along its avages or as fine veinlets in the green marginal zone. In both ses it commonly spreads out into rounded lobe-like areas on enter- g the central brownish hornblende, the latter evidently being the ost unstable variety. In regions of replacement small relics of the rlier amphiboles, in optical continuity with the original crystal, en remain. Occasionally a pale-coloured actinolite, similar to at of the marginal outgrowths, also replaces the hornblende in a in-like manner.

The zonal and replacement textures of the amphibole show that e crystallization sequence was brownish hornblende → actinolitic rnblende → actinolite → tremolite, indicating a progressive decrease alumina, soda, and iron.

Associated with the tremolite is a pale-coloured optically positive nnine, with $\alpha = \beta$ very pale green $> \gamma$ very pale yellowish-green ; etween 1·587 and 1·588 ; $\gamma - \alpha$ 0·004 ; and 'ultrablue' or weak ey interference tints. It sometimes occupies the central portion tremolite replacement-veinlets in the hornblende. Moreover, where ownish hornblende is replaced by lobes of tremolite the latter is nmonly associated with pennine and calcite. In such cases pennine

appears to have replaced tremolite to some extent, since disconnect relics of the latter, optically continuous with the main tremoli remain embedded in the pennine.

Large crystals of an almost colourless pennine sometimes conta central cores or isolated relics of biotite. In this case the penni (β = 1·588) evidently replaces biotite, and it contains strings o dense whitish material, resembling leucoxene, which follow t cleavage traces. Pennine with relics of biotite is sometimes enclos within the hornblende.

Locally the hornblendite is rich in biotite, which is partly enclo by and partly encloses hornblende. It is of a dull brown to greeni brown colour, commonly becoming greener towards the margin the flakes. The flakes average about 1·5 mm. across, but in patc they reach a size of 2 or 3 cm. They are particularly characteri by sharp crumpling.

Interstices between the amphibole and biotite or pennine crys are occupied by large anhedral crystals and finely-granular aggrega of calcite; radiating tufts of pennine; and fibres of tremolite. latter penetrate both pennine and calcite. In many instances cal is also interlaminated with tremolite.

Finally, there has been replacement of the earlier minerals calcite, which cuts across all the other constituents in veinlets, sometimes occupies considerable areas in which small isolated siduals of optically continuous amphibole remain.

Accessories consist of apatite, as large stumpy prisms, and sp pyrite and iron ore.

The crystallization sequence of the hornblendite, as indicate zoning and replacement textures, was as follows: hornblende biotite; amphiboles successively less aluminous than the orig hornblende; actinolite; tremolite; pennine; calcite. The crystal tion periods of the last three minerals appear to have been in simultaneous; the final mineral deposited, however, is always ca The sequence indicates crystallization from a magma which bec progressively less rich in alkalis and alumina, and in which mag and lime became concentrated.

(*b*) *Appinite.*

The appinite of the marginal intrusions differs from the hornb ite in containing varying amounts of albite, perthite, and quart quartz commonly being intergrown with the felspars as micropeg

e. In addition apatite is more abundant than in the hornblendite. in the hornblendite, biotite is locally abundant, and the hornende shows outgrowths of, and replacement by, tremolite and tinolite. There are patches in which the hornblende is largely or nolly replaced by chlorite. The characteristics of the minerals are nilar to those—described in the following pages—of corresponding nerals in the metasomatized quartzite xenoliths. As in the metamatic rims, patches of quartz which appear isolated in thin section e sometimes optically continuous. The felsic constituents, including atite, are partially replaced by calcite, being much dissected by inlets of this mineral.

Quartzite Xenoliths.

The quartzite xenoliths consist almost entirely of a fine-grained saic of quartz grains in which a few larger individuals of quartz embedded. The quartz is characterized by strain shadows. lspar is present in very small amount, and it is impossible to tell ether it is an original constituent or the result of introductions. th albite and perthite are represented; they have characteristically ystalloblastic outlines with curved re-entrants around quartz grains, are usually clouded with an exceedingly fine brown substance. rthite sometimes encloses optically continuous blebs of quartz, us simulating a rude micrographic intergrowth. Calcite, chlorite, d pyrite are present in small amount, and sparse rounded detrital ains of zircon are characteristic.

The quartzite cores, in partially replaced blocks, are crossed by eams of minute bubbles which extend into the quartzite from the etasomatized rim. Sometimes such streams of bubbles, which pass om one quartz individual to another, cut through felspar, their ssage being marked by a clear band in the latter. This band is tically continuous with the remainder of the felspar, but is comtely cleared of inclusions, so that it contrasts sharply with the ouded neighbouring portions.

Here and there along the course of bubble-streams short veinlets calcite replace quartz. The veinlets may cut across the centre of artz grains or extend along their boundaries. In the latter case lcite projects, in minute antennae-like structures, from the sides of veinlet along the boundaries of neighbouring quartz grains—a pical replacement texture. Such calcite veinlets begin and end ruptly in thin section, being continued at either extremity by a

stream of bubbles. Similar streams of bubbles, which locally pass into veinlets of calcite, or rarely quartz, are also present in the metasomatized rims, and from the latter they are sometimes traceable into the quartzite.

Veinlets of felspar (perthite and albite) with which chlorite is occasionally associated, extend into the quartzite from the metasomatized rims. They usually take a highly sinuous course, since they are generally developed along the boundaries of quartz grains. Like the calcite, the felspar fingers out from the sides of the veinlets along the boundaries of neighbouring quartz grains (pl. XII, fig. 6), indicating that it replaces quartz. Occasionally felspar veinlets cut across large individuals of quartz. Here again the felspar fingers out on either side of the veinlet, but in this case it extends into a quartz crystal instead of along intergranular boundaries. As a consequence of this invasion, the quartz shows lines of stress radiating from each felspathic finger.

(*d*) *Metasomatized Quartzite.*

As already described in the field section (p. 372), most of the quartzite xenoliths are partially or wholly altered to varieties of syenite and appinite, the syntectic rock types occurring either separately or in concentric zones in individual xenoliths. In the latter case syenite adjoins the centrally placed residual core of quartzite.

(i) *Minerals and Textures.*

In the syntectic rocks, perthite, albite, hornblende, actinolite, tremolite, chlorite, epidote, allanite, apatite, pyrite, sphene, and calcite have developed as a result of metasomatic introductions. In addition, quartz and zircon are present, having persisted from the original quartzite. The quartz has usually recrystallized, whilst the zircon generally retains its detrital form.

The syntectic rocks form a series, ranging from micropegmatite and quartz-rich syenite to melanocratic appinite, the various members of which differ in the relative proportions of mafic to felsic constituents. Moreover, whereas hornblende is characteristic throughout the greater part of the series, chlorite is the common mafic mineral, usually to the exclusion of hornblende, in the more leucocratic varieties. A wide range of textures are developed, and much variation is sometimes shown within a single rim. It should, however, be stressed at the outset that the rocks constituting the rims ha

n igneous aspect, and that in no case, without the complete evidence, ould they be suspected of having originated as replacements of re-existing rock.

Felspars. Perthite occurs both as subhedral to anhedral crystals nd in micropegmatitic intergrowths with quartz. The potash-felspar f the perthite shows simple twinning of Carlsbad type only. Albite present in the potash-felspar in irregular areas at the margin, and minute discontinuous veinlets and patches, optically continuous ith the marginal albite, within the crystal. In some instances the einlets are directly continuous with the marginal albite, and have ne appearance of being outgrowths from the latter. Dependent on ne orientation of the section, the albite veinlets either extend parallel the vibration-direction of the slow ray in the potash-felspar or ake an acute angle with that direction, the maximum angle easured being 30°. The data indicate that the veinlets extend arallel to the intersection of the basal plane and one of the primary rism faces. In some sections the albite appears as small patches hich tend to have straight margins parallel to the *c*-axis, but are herwise of irregular outline. The albite is usually untwinned, but may show an occasional patchy development of albite lamellae. ore rarely, albite is present in the potash-felspar as larger and less equent patches in which albite lamellae are easily visible and are ten of 'chess-board' type.

The ratio of albite to potash-felspar in the perthite varies within de limits. From the examples described above there are gradaons, through varieties in which potash-felspar is almost completely argined by albite, to a type in which potash-felspar is present only disconnected patches in albite. Finally, there are examples in hich potash-felspar appears as very small and sparse patches within hedral or subhedral albite. The albite in these cases does not velop albite lamellae, except in rare small patches, but, like the tash-felspar, it exhibits twinning of Carlsbad type.

The relations exhibited between albite and potash-felspar in the rthitic intergrowths suggest that the former replaces the latter (cf. 'patch perthite' of Andersen [1]). Further, the fact that in the re instances where albite lamellae are present their development of 'chess-board' type is significant, since this texture commonly ults from replacement. It cannot, however, be overlooked that

[1] Olaf Andersen, The genesis of some types of feldspar from granite-pegmas. Norsk Geol. Tidsskrift, 1928, vol. 10, p. 170, pl. 3, figs. 2 and 3.

the felspars are here known to replace quartz, and it is therefo possible that the textural features displayed by the perthitic inte growths may result from the simultaneous growth of potash-felsp and albite in a solid medium, being in fact a crystalloblastic develo ment. Albite is also present, however, as euhedral to subhedr crystals in which no trace of potash-felspar has been observed. Suc crystals stand in strong contrast to the albite of the perthite, since them albite lamellae are well developed; the lamellae are common persistent across the crystals, but are occasionally of 'chess-boar type. In the forefront of the replacement rim the polysynthetical twinned albite is sometimes seen to be directly replacing quartz. is therefore possible that the twinned albite results from replaceme of quartz, whereas the untwinned variety replaces potash-felspar.

The ratio of albite (well-twinned variety) to perthite varies fro one specimen to another. Usually albite is considerably less abunda than perthite. In some instances, however, it is as abundant perthite, and occasionally it is the more abundant felspar. It is oft micropegmatitically intergrown with quartz and two types of su intergrowth have been recognized. In one, quartz, and in the oth albite appears to form the host mineral. Similar micropegmati relationships between albite and quartz, in reconstituted xenoli from the Dartmoor granite, have been recorded and figured Brammall.[1]

Both the untwinned albite of the perthite and the twinned cryst exhibit a faint brown clouding due to the presence of minute opac inclusions, some of the larger of which can be seen to be ragged fla of haematite. In the well-twinned albite the clouding is sometir arranged in bands parallel to the albite lamellae. The potash-fels of the perthitic intergrowths, although it contains sparse inclusi of a similar kind, is relatively clear.

Occasionally both perthite and twinned albite are crowded w sericite[2] flakes. This development of sericite is quite sporadic a cannot be correlated with any particular position in the repla xenoliths. Aggregates of sericite, in which no felspar is visible, locally developed. Both perthite and twinned albite are sometir rendered opaque by the presence of a grey substance, associated w

[1] A. Brammall and H. F. Harwood, The Dartmoor granites: their ger relationships. Quart. Journ. Geol. Soc. London, 1932, vol. 88, pp. 205, 207

[2] The term sericite is used throughout this paper without implication as to potassic or sodic character of the mica.

ricite. In such instances the felspar is visible only in small clear eas near the margin, the actual margin being clouded with a fine own substance.

Where a core of quartzite remains in the metasomatized xenoliths e limit of general felspathization can be seen, in thin section, to be arp. The felspar of the replaced portion, however, extends into e quartzite in minute antennae-like processes which are frequently veloped along the margins of adjacent quartz grains (pl. XII, . 6; see also pl. XIII, fig. 4 of the following paper[1]). This fact dicates that the felspar-forming materials penetrated the quartzite ost readily along intergranular boundaries. In places felspathiza- n has spread in this way along the boundaries of neighbouring artz grains for a short distance in advance of the limit of general placement. In such examples the quartz grains may have the pearance of being embedded in a sparse felspathic matrix, or, with greater development of felspar at the expense of quartz, they may pear as rounded poikilitic inclusions in a felspar crystal. Narrow in-like forms of felspar sometimes extend from the metasomatic into the quartzite. They, like the rim itself, are margined against quartzite by antennae-like processes of felspar which extend ween adjacent quartz grains (pl. XII, fig. 6).

The antennae-like outgrowths of felspar are not, however, restricted the intergranular boundaries. Where a large quartz grain margins replaced portion, it is penetrated by such felspathic outgrowths ich terminate bluntly within the grain (text-fig. 3). Sometimes ge quartz grains are in this way much dissected. Not infrequently ge quartz grains lie across the metasomatic boundary, one part ng in the quartzite and the other in the felspathized zone. In h cases the felspathization can often be seen to take place along inite crystallographic directions, the quartz becoming cut up into mb-shaped portions, of roughly similar size, which exhibit straight inction with the diagonals of the rhombs (text-fig. 4). This sug- ts that the felspar-forming materials penetrate quartz most readily ng rhombohedral planes, and is possibly an indication that quartz a coarse rhombohedral mosaic structure.

Quartz. The percentage of quartz in the metasomatized quartzite oliths is very variable. In some cases quartz is absent, whereas thers it is present in amount comparable to that of granitic

[1] A. Holmes, Transfusion of quartz xenoliths in alkali basic and ultrabasic s, south-west Uganda. Min. Mag., 1936, vol. 24, p. 421.

rocks. For the most part the quartz has recrystallized so that t grain-size has become considerably coarser than that of the quartzi cores. In many examples it forms micropegmatitic intergrowt with the felspars; in others it is associated with the felspars granitic fashion; and in others again it is interstitial. Where exhibits granitic texture or occurs interstitially, neighbouring isolat portions are often optically continuous.

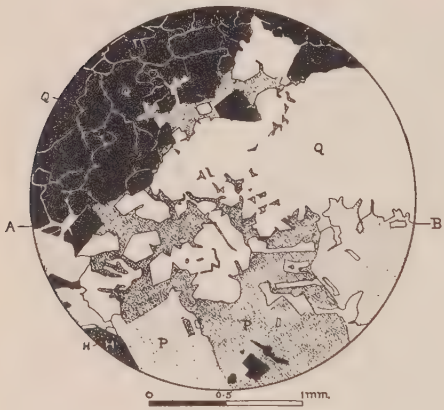


Fig. 3.

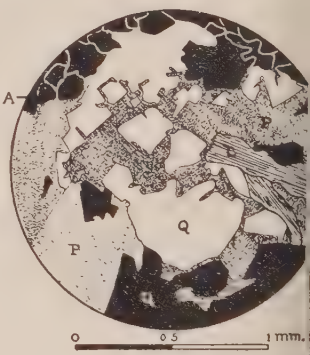


Fig. 4.

Fig. 3. Contact between the residual quartzite and the replaced portion xenolith. A–B marks the limit of general felspathization. Q = quartz, I perthite, and H = hornblende. The quartz shown white is all part of one in vidual, which has been partially felspathized. A replacement veinlet of fels extends, from the zone of general felspathization (below A–B), along the ma of this large grain, penetrating the latter and spreading into the adjacent sma grains via their intergranular boundaries.

Fig. 4. Contact between the residual quartzite and the replaced portion xenolith. A–B marks the limit of general felspathization. Q = quartz, l perthite, and C = chlorite. The quartz shown white is all part of one individ which has been partially felspathized, the felspar mainly following rhombohe planes.

The anhedral quartz almost always shows strain shadows, shadows, in every observed case, extending parallel to the vibrati direction of the slow ray. This appears to indicate that the st is developed in planes parallel to the *c*-axis. Occasionally the st gives an appearance of lamellar twinning parallel to the *c*-a alternate lamellae extinguishing simultaneously at a small a with *c*. The strained quartz is distinctly biaxial.

n the micropegmatite the quartz sometimes, but not always, ws strain. Where intergrown with albite the direction of the in lamellae makes a high angle with the albite lamellae in all erved cases.

he quartz is crossed by lines of dot-like inclusions which include h gas bubbles and minute irregular specks of an opaque material.

Hornblende of the same type as that which characterizes the hornndite is present in the metasomatic rocks. It shows similar, ugh less conspicuous, zoning in which the brownish-green variety $c = 20°$, γ' 1·657 ± 0·002, $\gamma - \alpha$ 0·019, negative, 2V close to 90°) urs centrally, and merges outwards to green hornblende ($\gamma : c = 18°$, ·643 ± 0·002, $\gamma - \alpha$ 0·020, negative, 2V close to 90°). The latter builds independent but relatively small crystals which particuy characterize the forefront of replacement rims. Outgrowths remolite and actinolite are less common than in the hornblendite, replacement of the early hornblende by these two amphiboles often taken place. Felted aggregates of actinolite are sometimes ent, and appear to replace leucocratic constituents as well as ier hornblende.

he hornblende occurs both as isolated crystals and in aggregates. ten builds euhedral crystals which vary in habit from stumpy longated prismatic. Subhedral forms are also evident in which m and clinopinacoid faces are usually well developed, while the inations are irregular, and not infrequently have a frayed appear-e. More rarely the faces of the prism zone show an irregular elopment. Simple twinning parallel to (100) is not uncommon. he hornblende exhibits a variety of textures. In cross-section metimes has the appearance of being only half developed. Such ppearance is usually taken to indicate that the crystal is broken. the present instances, however, where the hornblende results a metasomatic introductions into solid rock, such an interpretais untenable, and the appearance probably results from irregular th of hornblende in the vertical zone. Curved crystals are mon. In addition to the frayed terminations, already mentioned, ayed margins and sieve-like inclusions of quartz, felspar, and opegmatite are occasionally exhibited (text-fig. 5). Crystal s often have the appearance of being abruptly truncated against leucocratic constituents. In some examples the crystals have ppearance of being split apart, along cleavage planes, by lamellae uartz or felspar which are optically continuous with neighbouring

crystals (text-fig. 6). Portions of hornblende, which may be exce
ingly small, are in places isolated from, although optically continu
with, the main crystal. These textures, several of which are co
monly regarded as evidence of corrosion, can here only be interpre
as crystalloblastic developments, dependent on the fact that cryst
lization has taken place in an essentially solid medium.

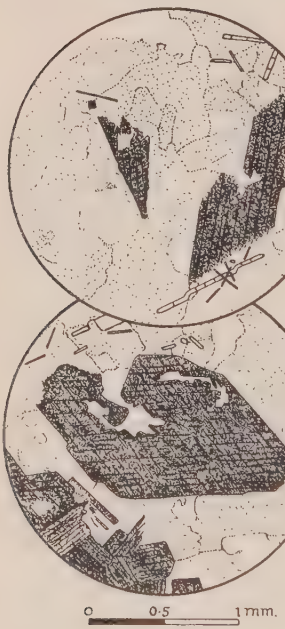


Fig. 5.

Fig. 6.

Fig. 5. Crystalloblastic developments of hornblende in the replacement
of a quartzite xenolith, illustrating textures commonly attributed to corros

Fig. 6. Hornblende from the metasomatized rim of a quartzite xeno
showing replacement textures which simulate mechanical distortion
'splitting apart' along cleavage planes.

It must not be supposed, however, that such crystallobl
textures are always the most characteristic. Just as common
even in the same slides—the hornblende exhibits euhedral or
hedral form. Where this is the case the rock would not, wit
the excellent field evidence, be suspected of having originated in
way other than by crystallization of magma. It should be stre
that hornblende, even when it is euhedral, may be either ent

nclosed within felspar, quartz, or micropegmatite, or it may cut ross the boundaries of these minerals.

Chlorite is present both as a replacement of hornblende, which is metimes completely pseudomorphed, and as a direct replacement f quartz and felspar. It has $\alpha = \beta$ bluish-green $> \gamma$ very pale green, nd is optically positive with 2V very small. In measured exmples from a rim of appinitic composition β is about 1·589 and $\gamma - \alpha = 0{\cdot}0045$. The data indicate that it is clinochlore not far om pennine in composition.

Where it replaces hornblende, the chlorite is commonly fibrous, which case it extends along the cleavage planes; in some examples, owever, it builds aggregates of small spherulites. Where chlorite places quartz and felspar it often builds aggregates of small spherutes which exhibit bulbous boundaries towards the replaced minerals. rom the spherulites, vermicular chlorite commonly fingers out into th quartz and felspar. In some examples, more noticeably in renitic types of replacement and in the forefront of the replaceent rims, chlorite which replaces felsic constituents develops ystal form and exhibits lamellar twinning parallel to (001).

In rare instances, chlorite encloses felspar and euhedral crystals hornblende, the latter sometimes terminated in toothed outgrowths tremolite.

Chlorite is also present in little veinlets which are situated along e boundaries of quartz and felspar. Such veinlets are in places aceable into calcite veinlets.

Allanite is common in the syntectic syenite and rare in the syntic appinite. It builds small euhedral crystals (usually about 13 mm. across, and rarely reaching a size of 0·3 mm.) in which 00), (10$\bar{1}$), and (001) are developed. It is strongly zoned, the rker zones occurring in the centre of the crystal, and has γ dark own $> \alpha$ pale brown; $\alpha : c = 36°$, and the birefringence is low. ne allanite is sometimes intergrown with or surrounded by epidote. ne latter mineral also occurs separately, in which case it is sometnes, but not always, associated with chlorite.

Calcite is common both as large anhedral crystals, intergrown with other minerals, and in veins which cut through the other minerals. e large crystals are in some cases seen to antedate the aggregates chlorite spherulites. This is inferred from the fact that the lorite fingers into the calcite, and occurs within it as vermicules, t as it does in the quartz and felspar.

From the large crystals of calcite, antennae-like structures exten along the boundaries of neighbouring individuals of quartz an felspar, or actually penetrate these minerals. In some instance veins of calcite extend from the crystals, and from the sides of th veins calcite fingers into the felsic constituents. Some of these vein terminate as single or bifurcating veinlets of quartz. The larg individuals of calcite exhibit lamellar twinning, and the lamella are in many cases curved.

Apatite has been introduced both as abundant needles, sometime of minute dimensions, and as crystals which may be much elongate in habit or short prismatic. The crystals either occur enclose within quartz, felspar, and hornblende, or they cut across th boundaries of these minerals. They are frequently clouded wi swarms of minute rod- and dot-like forms of an opaque minera The needle-like apatite is often highly concentrated in quartz an felspar.

Apatite reaches its maximum development in the appinitic ty of replacement. It is sometimes sporadic in its occurrence, tendi to segregate at certain points. Although commonly perfectly forme it occasionally has finely crenulate margins and fingering termin tions. In many instances the crystals are curved, and elongat crystals are not infrequently disconnected parallel to the base, t isolated portions being either in line or in echelon.

Pyrite is common, and reaches its maximum development in t appinitic type of replacement. It occurs within both felsic a mafic minerals and, although it often develops cubic form, it son times exhibits typical replacement textures, antennae-like proces of pyrite extending from an anhedral central mass, along the int granular boundaries of neighbouring quartz and felspar. In so instances compact crystals of pyrite poikilitically enclose apatite a hornblende.

Sphene is one of the less common minerals. It usually bui euhedral crystals, most of which are small, though occasional la examples, up to 0·5 mm. across, are present.

Zircon, with a rounded detrital form, as in the quartzite, persi in the metasomatized portions. It occurs as inclusions in qua and felspar, some of which lie across the mineral boundaries. V rarely it is crystalloblastic in its development, when it exhib curious sigmoid forms.

(ii) *Rock Types.*

The various products of replacement, regarded as rock types, may ow be briefly described:

Micropegmatite, which may be devoid of mafic minerals or may ontain hornblende and/or chlorite, is common in the forefront of he replacement rims around residual cores of quartzite (pl. XII, gs. 4 and 6). The felspathic rims described on p. 372 of the field escription under types 1 and 2 usually consist of micropegmatite. n some of these felspathic rims, however, only the innermost margin onsists of micropegmatite; away from the quartzite this passes into ucocratic syenite or quartz-syenite.

Syenite. Under this term is included a series of rocks which nges between micropegmatite and appinite. There are leucocratic uartz-free syenites which fall within Phemister's [1] delimitation of rthosite, and closely allied to these are varieties gradational wards leucocratic micropegmatite. The latter varieties of syenite ffer from perthosite only in the presence of a little quartz; they ay be termed quartz-perthosite. The mafic minerals of the pertho- es and quartz-perthosites, chlorite, allanite, and epidote, are esent only in accessory amount. By the incoming of hornblende e perthosites grade through hornblende-syenite, which is usually uartz-bearing, to appinite. The various types of syenite respectively aracterize different xenoliths; they also occur, in some instances, association within a single xenolith.

The analysed syenite (table II, no. 3), collected from a large nolith that is almost completely replaced by pink syenite, is a artz-perthosite characterized by albite, perthite, and quartz, with cessory chlorite, allanite, epidote, calcite, sphene, zircon, apatite, d pyrite. Texturally it varies from roughly equi-granular to iate-granular (pl. XII, fig. 3). The felspars tend to develop form, ilst the quartz occurs interstitially or intergrown in granitic hion with the felspars. In many instances portions of quartz, ough completely isolated in thin section, are optically continuous. lorite is subhedral to anhedral in form, and sometimes shows stalloblastic development. In the latter case, it has outlying tically-continuous portions and, rarely, is sieved with inclusions the leucocratic constituents. In the sections examined, the

[1] J. Phemister, The geology of Strath Oykell and Lower Loch Shin. Mem. ol. Surv. Scotland, 1926, p. 47.

chlorite does not appear to replace an earlier ferromagnesian minera
Sericite is sparsely dispersed through the felspars, and calcite replace
the felspars in small veinlets and irregular patches.

In perthosite, which is free or almost free from quartz, the felspar
although they are mutually intergrown, show an approximation t
rectangular outline in thin section. Crystalloblastic textures a
sometimes developed; in some instances, for example, twinne
albite, with crenulate margins, has optically-continuous outlyi
portions.

In the syenites which are rich in quartz, micropegmatite
developed. These rocks grade from a variety which contains ma
minerals in accessory amount only to quartz-bearing hornblend
syenites. Both the quartz-rich syenites and the micropegmatit
exhibit textures which characterize micropegmatite-bearing rocks
general. The micropegmatite may be coarse in texture or of a fin
feathery variety. Euhedral crystals of felspar are sometimes op
cally continuous with the felspar of the surrounding micropegmatit
Anhedral quartz is similarly sometimes optically continuous wi
the quartz of neighbouring micropegmatite. In some instances
single quartz crystal is intergrown with two or more different
orientated crystals of felspar. In short, there is no textural cl
from which it could have been suspected that the metasoma
micropegmatite did not arise as a result of the crystallization
magma.

A point of special interest in the syenitic type of replacement is t
relation between quartz and felspar. In the forefront of the repla
ment rim, felspar develops along the margins of quartz grains, t
latter sometimes remaining as inclusions in felspar crystals. Fartl
into the replacement rim the quartz has generally recrystallized.
it is present in only small amount it is interstitial, whereas wh
present in greater amount it is either micropegmatitically intergro
with the felspars or, less commonly, is associated with them
granitic fashion. The relationship between quartz and felspar
thus dependent in part on position in the replacement rim and
part on the proportion of quartz present.

As noted in the field section under type 1, p. 372, there is co
monly a narrow green zone, generally 1 or 2 mm. wide, situated
the contact between leucocratic felspathic rims and residual quartz
cores. In thin section this is found to differ from the main leu
cratic zone in the abundance of ferromagnesian material. Chlo

he most common mafic mineral, but green hornblende is some-
es present. A block of quartzite with a felspathic rim from the
rginal breccia appears to throw light on the origin of this narrow
en frontal zone. The quartzite of the block contains fairly
ndant biotite, yet the marginal felspathic rim is of leucocratic
ropegmatite rich in 'chess-board' albite. Immediately at the
tact with the quartzite, the micropegmatite contains chlorite
ether with a few flakes of biotite which have persisted from the
rtzite. Away from the margin, however, chlorite is rare in the
ropegmatite, and biotite, partly chloritized, is very rare, whilst
ile needles are common (pl. XII, fig. 5). The evidence suggests
t the constituents of the biotite from the quartzite became
bilized during the felspathization process, the Mg and Fe being
ried forward to the forefront of the zone of replacement.

Appinite. The appinites, which are all quartz-bearing, range from
nblende-syenite to varieties which differ from the hornblendite
y in the presence of a little felspar and quartz. They contain
nblende of the brownish and green varieties which characterize
hornblendite; actinolite and tremolite, which are present both
replacements of and outgrowths from hornblende, the actinolite
metimes being present also as irregular aggregates; perthite;
te; quartz; chlorite; calcite; apatite; pyrite; and rare allanite
epidote. The characteristics of these minerals have already
n described.

uartz is often micropegmatitically intergrown with the felspars,
it also occurs interstitially and associated in granitic fashion
the felspars. As in the syenites, isolated portions of quartz are
any instances optically continuous.

he appinites vary in grain from medium to coarse, and are
tically always coarser in grain than the associated syenites. The
vsed appinite (table II, no. 2) contains blade-like crystals of
blende up to 6 cm. long, which are embedded in a pink quartzo-
athic matrix. In common with many examples of the apinitic
of replacement, small druses, margined by calcite crystals which
bit form towards the cavity, are present.

Syntectic Veins.

ne pegmatite veins, which arise from the narrow felspathic zone
loped at the margin of the quartzite against the hornblendite
376 and pl. XI, fig. 4) and penetrate the latter rock, show rapid

variation from point to point. One such vein about six inches wi from which the analysed specimen (table II, no. 5) was collect varies, in a single hand-specimen, from quartz-perthosite of eq granular texture to leucocratic micropegmatite-bearing syeni There are, moreover, patches in the vein which are rich in chlor (prochlorite with β about 1·61) and epidote. The chlorite usua replaces and often retains cores of biotite, the latter with crump cleavage traces. The epidote, which is associated with the chlor is more strongly coloured than that in the replacement rims. I ore is a common associate of chlorite.

The felspars are albite and perthite, the latter with a pat development, as in replacement rims. In chlorite-rich regions felspars are commonly crowded with flakes of sericite, amongst wh apatite is often segregated. The apatite characteristically devel acicular crystals up to 3 mm. long. These are sometimes curved arranged in echelon. The rock contains large patches of calc up to a centimetre across, and where it adjoins the hornblendit contains hornblende similar to that in the latter rock but of bla habit and up to several centimetres in length. So far as could judged, the analysed specimen was free from hornblende, but it c tained some chlorite and epidote.

Texturally the pegmatite is closely similar to the correspond rocks of the replacement rims and, except that epidote is c siderably more abundant and the chlorite is prochlorite instead clinochlore or pennine, there are no obvious criteria by whic could be distinguished from these.

The syntectic veins which form a network in the hornblen (p. 375) are of the composition of appinite or mafic syenite. T are composed of hornblende, a little tremolite, and actinc chlorite, perthite, albite, and quartz, together with accessory apa epidote, sphene, pyrite, and calcite. The characteristics of t minerals are similar to those of the corresponding minerals in replacement rims. The hornblende is for the most part euhe but it occasionally has frayed margins, re-entrants, and sieve inclusions of the felsic minerals. It sometimes has outgrowt tremolite and actinolite and may be partially replaced by chlo The quartz is in part interstitial, in part intergrown with the fel in granitic fashion, and in part a constituent of micropegmatite. I two former cases neighbouring patches of quartz are sometimes cally continuous. This latter texture, together with those sugge

crystalloblastic development exhibited by the hornblende, prob-
y indicates crystallization in a highly viscous medium. Indeed,
in the case of the pegmatite, there is, in thin section, no obvious
terion which distinguishes these veins from the replacement rims.
in the latter, calcite replaces the other minerals to some extent.
In the 'tails' which extend from metasomatized quartzite xeno-
ns (p. 375, pl. xi, fig. 2 and pl. xii, fig. 2) the minerals and
tures are again essentially similar to those which characterize the
lacement rims; allanite is occasionally present.

Syenite.

No systematic petrological investigation of the syenite of the main
rusions has yet been made, but the following notes, made from
udy of a few thin sections, indicate their similarity to the rocks
he replacement rims.

The syenite of the two intrusions of Port Easdale consists of
hite, albite, quartz, abundant chlorite (prochlorite with
612 $\pm$ 0·002), and epidote, together with accessory apatite, pyrite,
nite, and calcite. The chlorite and epidote, in the thin sections
mined, have no appearance of having replaced earlier ferro-
gnesian minerals. The texture is seriate-granular with the con-
ents ranging from subhedral to anhedral. Neighbouring patches
uartz, which are isolated in thin section, are in many instances
ically continuous. The syenite of the intrusion on the hill to the
th of Port Easdale contains hornblende, which is partially altered
hlorite.

Mineralogically and texturally, the syenite of the main intrusions
ery similar to parts of the pegmatite veins. Moreover, the
ence of allanite indicates consanguinity with the rocks of the
acement rims and the syntectic veins derived from them.

5. Chemistry.

In tables II and III the chemical analyses and norms of the rock
es are listed. The hornblendite (1) was collected from a zone
from quartzite xenoliths in the intrusion which margins the
hern shore of Port Easdale. It is typical of the felspar-free
blendite which characterizes both the Port Easdale intrusions.
ffers from analysed hornblendites of other areas in being richer
agnesia and poor in alkalis.

ne quartzite (4) is the residual part of a typical quartzite xenolith
the southern intrusion.

The appinite (2) and the syenite (3) were collected from relativ large metasomatized quartzite xenoliths, which retain residual co

TABLE II. Chemical analyses.

	1.	2.	3.	4.	5.	6
SiO_2	42·54	52·30	66·04	95·17	68·38	57
Al_2O_3	9·00	15·23	17·68	3·45	14·00	12
Fe_2O_3	1·84	2·29	0·33	0·12	1·10	5
FeO	7·80	5·30	0·94	0·09	0·54	3
MgO	19·41	5·77	0·20	0·04	0·51	2
CaO	10·82	7·85	1·81	0·38	4·00	5
Na_2O	0·53	2·16	4·95	0·01	5·49	3
K_2O	0·33	3·00	5·16	0·37	3·78	4
H_2O+	4·61	1·76	0·80	0·08	0·48	1
H_2O-	0·17	0·09	0·11	0·07	0·06	0
CO_2	1·81	0·90	0·97	nil	0·86	0
ZrO_2	nil	nil	0·15	0·14	0·02	0
TiO_2	0·74	0·72	0·11	0·09	0·09	0
P_2O_5	0·08	1·11	0·18	0·06	0·26	0
Cl	0·01	n.d.	n.d.	n.d.	n.d.	n
S	0·15	1·37	0·06	0·06	0·06	0
Cr_2O_3	0·08	trace	nil	n.d.	n.d.	n
V_2O_3	0·05	0·04	0·02	n.d.	n.d.	n
NiO	0·10	0·17	nil	n.d.	n.d.	n
MnO	0·18	0·14	0·02	trace	0·03	0
SrO	nil	0·02	nil	trace	0·08	0
BaO	nil	0·09	0·15	nil	0·09	0
Li_2O	trace	n.d.	n.d.	n.d.	n.d.	
	100·25	100·31	99·68	100·13	99·83	9
Less O	0·06	0·51	0·02	0·02	0·02	0
	100·19	99·80	99·66	100·11	99·81	9

1. Hornblendite. Northern shore of Port Easdale. Analyst, L. S. Theo
2. Appinite. Rim of quartzite xenolith. Southern shore of Port Eas Analyst, Agnes Gibbs.
3. Syenite. Rim of quartzite xenolith. Southern shore of Port Eas Analyst, Agnes Gibbs. A second analysis made on another samp material from the same specimen gave SiO_2 65·85, Al_2O_3 18·30.
4. Quartzite xenolith. Southern shore of Port Easdale. Analyst, Agnes G
5. Pegmatite. Syntectic vein in hornblendite. Southern shore of Easdale. Analysis by Messrs. Imperial Chemical Industries Ltd., Res Dept., Billingham, Co. Durham.
6. Syenite. Intrusion south of Port Easdale. Analysis by Messrs. Im Chemical Industries Ltd., Research Dept., Billingham, Co. Durham.

of quartzite; both are from the southern intrusion. The app is a somewhat leucocratic variety transitional to hornblende-sye The syenite falls within Phemister's (loc. cit.) delimitation of thosite, except that it is quartz-bearing. The latter fact acc

r its lower alkalis and alumina, relative to silica, as compared with e perthosite of Loch Ailsh.

The appinite and syenite which result from the transfusion of uartzite xenoliths are chemically, as well as mineralogically and

TABLE III. Norms of analyses in table II.

		1.	2.	3.	4.	5.	6.
... ...		—	7·16	15·71	92·96	17·85	9·88
... ...		—	—	3·20	2·56	—	—
... ...		—	—	0·22	0·20	0·04	0·02
... ...		1·89	17·75	30·50	2·13	22·32	27·44
... ...		4·51	18·25	41·89	0·11	46·45	30·20
... ...		21·20	23·01	2·03	1·26	2·39	5·37
$CaSiO_3$		8·59	1·65	—	—	1·47	4·82
$MgSiO_3$		6·26	1·18	—	—	1·28	3·97
$FeSiO_3$		1·48	0·33	—	—	—	0·26
... ...		—	—	—	—	3·07	—
$MgSiO_3$		15·13	13·19	0·50	0·10	—	3·25
$FeSiO_3$		3·59	3·79	1·19	—	—	—
Mg_2SiO_4		18·87	—	—	—	—	—
Fe_2SiO_4		4·90	—	—	—	—	—
... ...		0·11	—	—	—	—	—
... ...		2·66	3·31	0·48	—	1·37	8·12
... ...		—	—	—	0·13	0·16	—
... ...		1·76	1·72	0·21	0·06	0·17	0·91
... ...		—	—	—	0·20	—	—
... ...		0·20	2·62	0·37	0·14	0·60	1·65
... ...		0·25	2·56	0·11	0·11	0·11	0·62
... ...		4·11	2·05	2·21	—	1·96	1·61
ter		4·78	1·85	0·91	0·15	0·54	1·82
		100·29	100·42	99·53	100·11	99·78	99·94

turally, normal igneous rocks. In text-fig. 7 their constituents plotted on a variation diagram together with those of the hornndite and quartzite. The diagram turns out to be of a common pe, such as is frequently interpreted as evidencing crystal differention, yet here the process was one of migration of various conuents from hornblendite magma into quartzite.

Comparison of the chemical analyses, or their diagrammatic representation on text-fig. 7, reveals the following important facts with ard to the syntectic appinite and syenite.

1) They do not represent admixtures of hornblendite and quartzite.

2) All the constituents, with the exception of SiO_2 and ZrO_2, pear to have been provided almost entirely by the hornblendite gma. The concentration of ZrO_2 in the quartzite and syenite

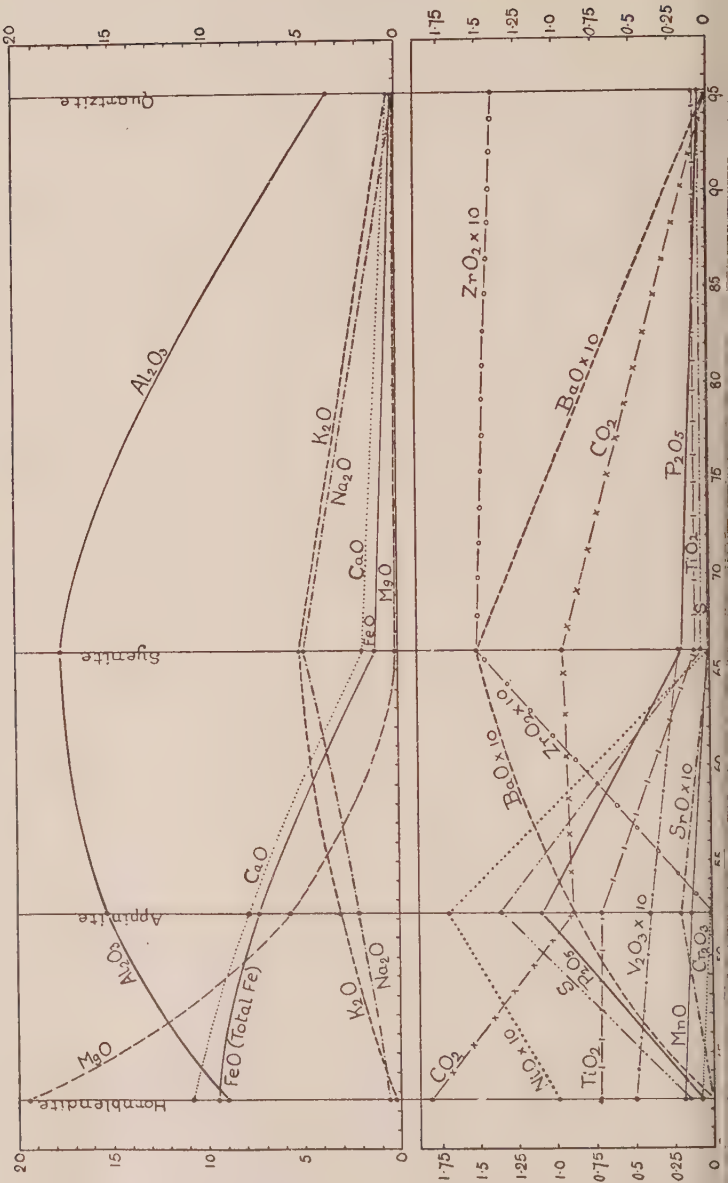


FIG. 7. Variation diagram for the series hornblendite–rim-appinite–rim syenite–xenolithic quartzite.

es with the observation that practically all the zircon in the ite exhibits a detrital form.

) Certain constituents, i.e. Al_2O_3, K_2O, Na_2O, P_2O_5, S, NiO, BaO, SrO, have actually become concentrated in the appinite and ite, Al_2O_3, K_2O, Na_2O, and BaO reaching a maximum in the ite, and P_2O_5, S, NiO, and SrO in the appinite. BaO is of icular interest since, although it is absent from both the hornlite and the quartzite, it is present in both the syenite and nite.

) Soda is more abundant than potash in the hornblendite, yet he appinite and syenite potash is more abundant than soda.

is evident, from the concave and convex curves of the variation ram, that the constituents of the hornblendite magma were duced differentially into the quartzite xenoliths. It is, however, at present apparent how the migration was effected; even to ss the migratory units in terms of oxides is to make an assump-. Remarks will therefore be restricted to the behaviour of vidual elements. It is particularly noteworthy that, although s by far the most abundant metallic element in the hornblendite, as the least diffusible, as shown by the downward slope and ve form of the curve representing MgO in text-fig. 7. Potassium, he other hand, which is now poorly represented in the hornlite, was amongst the most diffusible elements, as shown by the d slope and convex form (as far as the syenite) of the curve esenting K_2O in text-fig. 7. Similarly, barium, which is now ly absent from the hornblendite, was one of the most diffusible ents from its magma.

e migratory elements can be classified, for this area, as follows:

Most diffusible.	*Less diffusible.*	*Least diffusible.*
Al	Fe	Mg
K	Ca	
Na	C	
P	Ti	
S	Cr	
Ni	V	
Ba	Mn	
Sr		

will be recalled that the order of mineral formation in the blendite indicates crystallization from a magma which became verished in alumina and alkalis. The loss of the magma is thus ced by the major gains of the quartzite.

The circumstances which contributed towards the present distrib tion and relative concentration of the elements in the tranfus xenoliths probably include: (*a*) sequence of introduction into t xenoliths; (*b*) relative rate or power of diffusion through the xe liths; (*c*) sequence (in both space and time) of fixation by the xe liths. The various zonal arrangements of rock types in the transfu xenoliths (see pp. 372–3) suggest that (*a*) was an important fact potassium, sodium, and aluminium having been introduced bef the cafemic-forming constituents entered in force.

The analysed pegmatite (5) was collected from one of the 6-in syntectic veins described on p. 392 and figured on pl. xi, fig. Chemically it is a somewhat soda-rich quartz-syenite. Although had a similar origin to the syenites of the replacement rims, i chemically remarkable in that it differs from the analysed r syenite in containing more soda than potash.

The analysed syenite (6) was collected from the intrusion to south of Port Easdale. Chemically it is related to plauenite; alum is low, however, and iron high. Except for the low alumina high iron it very nearly fits the curves for the metasomatic rocks the variation diagram text-fig. 7.

6. Comparable Examples.

Ontario.—Quartzite xenoliths which have been similarly felspath and changed by a process of transfusion into rocks of igneous c position have been described by Collins from diabase sills. In 1 he recorded the presence of light-coloured red patches, of coa grain than the normal diabase, in the sills of the Gowganda distr The patches vary in size from about an eighth of an inch in diam up to several hundreds of feet in length. No evidence as to t origin, however, was found in this district. Later, in a study of gabbro sills of the north shore of Lake Huron, the origin of sim leucocratic patches was discovered.[2] At Blind River, for exam the gabbro contains many patches which are more leucocratic coarser in grain than the normal gabbro of the sill. Some of th contain cores of quartzite which are obviously remains of xeno

[1] W. H. Collins, The geology of the Gowganda mining division. Mem. Surv. Canada, 1913, no. 33, p. 63.

[2] W. H. Collins, North shore of Lake Huron. Mem. Geol. Surv. Canada, no. 143, p. 80. See also T. T. Quirke, Espanola district, Ontario. Mem. Surv. Canada, 1917, no. 102, p. 51.

ived from the neighbouring Mississagi quartzite. All stages of eration have been found in the sills from blocks of quartzite which only marginally corroded to others which are represented by ches of gabbro conspicuously lighter in colour and coarser in in than the normal sill rock. In some cases the inclusions are dered against the sill rock by a dark rim, varying from less than inch up to more than a foot in width, composed mainly of hornnde. In other examples, the altered inclusions merge insensibly o the normal gabbro. They are composed of an intimate interwth of hornblende, intermediate plagioclase, which is commonly phically intergrown with quartz, and some epidote.

The inclusions in one of the sills near Sudbury have been investied by Jones.[1] In this intrusion there are lens-shaped and gular bodies of white rock, with dimensions varying from a few up to 100 by 40 feet, some of which have a central core of quartz. such patch, about 42 feet in diameter, was studied in detail h chemical analyses. It has a marginal zone consisting of hornnde and bytownite and an inner zone, adjoining central quartz, andesine and quartz. In the outer zone the hornblende and ownite exhibit textural relationships similar to those of the nal sill rock. The hornblende crystals attain their greatest size ards the middle of the outer zone, where they reach a length of nches. From this region towards the centre of the mass they ome smaller and sparser, finally dying out. With the disappear- of hornblende the plagioclase changes from bytownite to esine.

nes concludes that the change in the xenolith took place in an ntially solid state by diffusion into it of various constituents n the gabbro magma. From the zonal character of the transfused sions he deduces that the various constituents had different trative abilities. Alumina, soda, and lime penetrated farther the xenolith than magnesia and iron.

lspathized xenoliths of quartzose sediment have been recorded Fenner[2] from the gabbro of the Sudbury lopolith. In places the liths are surrounded by a zone of rock which is similar to the ophyre of the upper part of the intrusion, whilst in other cases are so digested as to have almost disappeared. In explanation

[1] V. A. Jones, A study of certain xenoliths occurring in gabbro at Sudbury, io. Toronto Univ. Studies, Geol. Ser., 1930, no. 29, pp. 61–73.
[2] . N. Fenner, Journ. Geol. Chicago, 1926, vol. 34, pp. 735–736.

of phenomena of this type Fenner suggests 'that before and dur assimilation of the quartzose body it was soaked with vola material emanating from the magma, and that a modification of composition of the magma and the sediment was thus effected, m of the material lost by the magma being retained by the sediment

Bushveld, Transvaal.—Daly[1] has described, with chemical analy successive stages in the alteration of quartzite xenoliths in the m quartz-syenite and granite of the Bushveld complex. The chemica unaltered quartzite is grey or white in colour and generally conta little else besides quartz, the average silica percentage of f analysed varieties being 95·5. Descriptions of three xenoliths follows, illustrate the various stages in the alteration.

(*a*) A slightly altered xenolith from the mafic quartz-syenit pink in colour and contains 17 per cent. by weight of cloudy fels consisting of soda-rich orthoclase and oligoclase-albite (Ab_{92} about equal proportions. Subordinate constituents are rare gran of diopsidic augite and magnetite and a few blades of green h blende.

(*b*) A more altered xenolith, from the same rock, is redder in col about half of the rock being composed of felspar. The felspars similar to those in the last example, but the orthoclase, which is rich in soda, is more abundant than plagioclase. The rock cont a few shreds of biotite and a little magnetite. Texturally it di from the last example in that it contains some feathery micropeg tite. In spite of the intense felspathization, the rock retain cross-bedding, indicating that the alteration took place while xenolith remained essentially in the solid state. Chemical ana show that alumina, potash, and soda were introduced into the q zite; the process was, therefore, one of metasomatism.

(*c*) An even more altered xenolith, enclosed in coarse red gra shows no trace of original bedding. It contains about 40 per of quartz arranged in clumps; 50 to 55 per cent. of felspar; proportions of biotite and of hornblende with occasional cores of sidic augite; a few needles of apatite and very rare specks of ore. The felspars are perthite, in which orthoclase and practi pure albite are intergrown, and subordinate plagioclase. The an shows the rock to be a normal acid granite. Daly remarks tha the field all of the five geologists, including Dr. Hall, were impr

[1] R. A. Daly, Bushveld igneous complex of the Transvaal. Bull. Geo America, 1928, vol. 39, pp. 746–750.

h the igneous look of the xenolith. To explain it one of the working potheses used is that the present state of the xenolith may be the ult of ultra-metamorphism. The secondary magma may, however, ver have been quite homogeneous, but may have held in it, undis-ved, many grains of quartz, such as now appear in thin section as nded individuals, separate and in clusters.'

Illimausak, Greenland.—Inclusions of sandstone, surrounded by a e of soda-granite, have been described by Ussing[1] from the augite-nite of the Illimausak region, Greenland. From the descriptions the evidence, this appears to provide an example of transfusion sely analogous to that in Colonsay. The augite-syenite contains nerous inclusions of sandstone; the largest is over 100 metres long d 50 metres broad. All the fragments, large as well as small, are rounded by and separated from the augite-syenite by a zone, from alf to two metres wide, of soda-granite, which frequently contains rge number of very small rounded fragments of sandstone. From soda-granite rim small apophyses extend into the sandstone, and syenite, in the neighbourhood of the sandstone inclusions, is cut veins of soda-granite.

ssing's description of the rim is as follows: 'Directly surrounding sandstone there is always a black zone, not more than ½ a centi-er broad and containing exclusively black-green pyroxene or black blende in short prisms which lie at right angles to the surface of act; then comes a slightly broader, white zone, which consists rge anhedra of felspar and quartz with a relatively small amount lack minerals, and outwardly the white zone passes into the more orm soda-granite. The size of grain of the latter is sometimes able, so that coarse grained portions may alternate with fine-ned in the most irregular manner, even within one and the same d-specimen. . . . As a rule the junction between the soda-granite the surrounding augite-syenite presents a sharp line; the augite-ite retains its normal character right in to the contact.' It is aps a point of petrological significance that chemically the soda-ite of the rims is very similar to the large granite body of Illi-sak.

croscopically, at the contact between soda-granite and sandstone, egion of felspathization is seen to be advancing into the sandstone g the margins of the quartz grains.

[1] . V. Ussing, Geology of the country around Julianehaab, Greenland. Medd. rønland, 1912, vol. 38, pp. 51–54 and 116–118.

A point of special interest in the Illimausak occurrence, whic paralleled in Colonsay, is the evidence that the syntectic soda-gra became magmatic and remained fluid longer than the augite-sye which generated it, since, in the vicinity of sandstone fragments, augite-syenite is cut by veins of soda-granite.

Glen Coe, Scotland.—An example of felspathization of quart xenoliths has been recorded by Bailey[1] from the porphyrite fa intrusion of Glen Coe. The porphyrite is described as often be 'not only richly charged with xenoliths of baked mica-schist quartzite, but also loaded with quartz grains separated from quartzite'. Moreover 'the quartzite, where it retains its individual is frequently saturated with pink felspar from the porphyrite'.

In his petrological description of these metasomatized xenol Bailey records that the felspars developed in the quartzite are or clase and albite or albite-oligoclase. I am indebted to the Dire of the Geological Survey for allowing me to examine the thin sect of the altered quartzite xenoliths. It is a point of special inte that here, as in Colonsay and the Illimausak region, the felspath tion of the quartz takes place most readily along intergran boundaries.

That the quartzite xenoliths served to fix migratory alkalis is from Bailey's observation that the 'portion of the Fault-Intru which developes the permeation phenomena . . . differs from the coherent portions of the same intrusion in being much riche alkali'. At the time of writing, Bailey himself clearly realized importance of this observation for he adds, 'There is a tempting here for further careful work, and one which is likely to yield preg suggestions in regard to magmatic differentiation.'

General comments.—This section cannot be concluded wit reference to a recent paper by Collins[2] in which he reviews va examples, including those discussed in the previous pages, of al tion of xenoliths by diffusion into them of material from magr which they were enclosed. He finds (*a*) that in specific exa diffusion is not uniform for all constituents, some penetrating fa than others and being concentrated differently, as indicated by arrangements; and (*b*) that the penetrative power of various c

[1] E. B. Bailey, The geology of Ben Nevis and Glen Coe. Mem. Geol. Scotland, 1916, pp. 112, 164.

[2] W. H. Collins, Derivations of granitic rocks. Report XVI Internat. Congress, Washington, 1933, 1936, vol. 1, pp. 271–282.

ents varies from one locality to another. With regard to the alkalis, example, in one of the cited instances, potash penetrated farthest d in greatest abundance, and in another soda. He concludes that e process involved molecular transfer of highly mobile material and emical reaction, rather than a mechanical soaking into the solid rock the adjoining magma or a fluid portion of it. The present investigan confirms these conclusions, but I can see no reason for believing at the transfer was molecular rather than atomic or ionic. In lonsay not only has there been differential introduction of various nstituents into the xenoliths, but the latter have actually been con-rted to felspar-rich types although immersed in a magma which, crystallization, gave rise to an ultrabasic felspar-free rock. Although felspar-forming material penetrated most readily along the boun-y of quartz grains, it appears to have been capable of passing ough the crystal mesh of quartz (see p. 383), a fact which suggests e introductions. It is a point of interest that sodium ions have n experimentally passed through quartz parallel to the *c*-axis.[1]

7. Summary and Petrological Conclusions.

At Port Easdale, Colonsay, micropegmatite, syenite, and appinite e been developed by replacement of quartzite xenoliths engulfed rnblendite magma. The syntectic rock types occur either sepa-ly or in concentric zones in individual xenoliths. In the latter case ropegmatite or syenite adjoins the centrally placed residual core quartzite. The syntectic rocks also occur in the hornblendite as cratic patches and rarer schlieren without visible residual cores quartzite. The process involved the differential diffusion of the ious magmatic constituents into the quartzite; of the major con-uents, aluminium, potassium, and sodium appear to have been oduced first. Chemically, the rocks thus developed do not repre-a mixture of hornblendite and quartzite; Al_2O_3, K_2O, Na_2O, $_5$, S, NiO, BaO, and SrO have actually become concentrated in metasomatic varieties. Moreover, there is more potash than soda he metasomatic rocks, whereas the hornblendite contains more than potash.

he rocks which result from the transfusion of quartzite present gneous appearance, and without the field evidence it would not ossible to deduce that they are not 'igneous' in the common e of the term.

[1] C. H. Desch, The chemistry of solids. 1934, p. 115.

Finally, the process of transfusion gave rise to syntectic magn of syenitic and appinitic composition. This is represented by pegm tite veins developed from felspathized quartzite along the contact of the intrusion; by veins of syenite and appinite which emerge fro transfused quartzite xenoliths; and locally by an intricate netwo of such veins in the hornblendite, so that the latter appears as ma xenoliths in a relatively leucocratic matrix.

Arising out of the Colonsay evidence, the following points of ou standing petrogenetic significance may perhaps be emphasized.

(1) A field association of melanocratic and leucocratic rocks do not in itself constitute evidence of crystal differentiation as the mo of origin of the types concerned. Nor does such an association, ev though all gradations between the extreme types be represented, co stitute evidence that the whole of the rock materials once form part of a homogeneous magma.

The necessity for stressing this latter point is made apparent several recent discussions of which one, by Kennedy and Read,[1] m be taken as an example. A dike of markfieldite, which they descri is characterized on the one hand by patches, schlieren, and veins a leucocratic variety, and on the other by irregular patches a schlieren of a more mafic variety, the three rock types concern being linked by a complete series of transitional types. The stateme based on these field relations (loc. cit., p. 118), that 'there is escape from the conclusion that the heterogeneous nature of intrusion results from splitting or differentiation of an origina homogeneous magma' goes far beyond the evidence. The data p sented in the present communication provide one means of escap

(2) Sharp contacts do not necessarily indicate intrusive conta they may equally well represent diffusion limits.

(3) The facts that a rock exhibits an 'igneous' appearance, b in hand-specimen and microscope section, and is of igneous comp tion do not constitute evidence that it crystallized from a magma should be specially emphasized that rocks which many petrolog have tacitly assumed to be of igneous origin may be metasom replacements.

(4) The enclosure of crystals, even though they are euhedral other minerals does not constitute evidence that the enclosed min

[1] W. Q. Kennedy and H. H. Read, The differentiated dyke of Newm Dumfriesshire, and its contact and contamination phenomena. Quart. Jc Geol. Soc. London, 1936, vol. 92, pp. 116–145.

s the first to crystallize; its constituents may have been introduced a later stage.

(5) Micropegmatite does not necessarily result from the crystallization of magma of eutectic or other composition. This point has already en emphasized by many writers.

(6) The presence of abundant apatite is frequently taken as idencing a concentration of volatile constituents and, in consquence, of indicating that the rock in which it occurs crystallized m a highly fluid magma. In the appinite of metasomatic origin scribed in the present communication, apatite is highly concentrated, rticularly in the felsic constituents, occurring both as fine needles l prismatic crystals. Yet the rock has never existed in a state ier than essentially solid.

7) Curvature of crystals or their twin-lamellae does not necessarily icate external stress; it is a characteristic replacement texture.

8) Strain shadows in quartz do not necessarily result from external ss; they may also result from strain dependent on metasomatic roductions. This point and those referred to under 2, 3, 4, 7, 9, 13 are the more necessary of emphasis in that such structural, tural, and chemical features of certain of the rocks of the Killarney a, Ontario, have been presented by Jones[1] as if they were evidence avourable to Quirke's[2] conclusions that the rocks result from the sfusion of quartzite. Actually, however, not one of the facts cited Jones is inconsistent with such a metasomatic origin.

9) The fact that a mineral has the appearance, in thin section, of g only half developed is not necessarily an indication that it is a ken crystal. In Colonsay, hornblende which results from introtions into rock which was essentially solid sometimes has this earance.

10) Crenulated and frayed margins, sieve-like inclusions, and itting apart' of minerals along their cleavages are not necessarily cative of corrosion. Nor are sieve textures necessarily indicative ontact alteration. Minerals which develop as the result of metaatic introductions may exhibit such textures, e.g. hornblende in rocks described in this paper.

11) Ability to construct a normal variation diagram for a rock

[1] W. A. Jones, The petrography of the rocks in the vicinity of Killarney, rio. Toronto Univ. Studies, Geol. Ser., 1930, no. 29, pp. 39–60.

[2] J. T. Quirke, Killarney gneisses and migmatites. Bull. Geol. Soc. America, vol. 38, pp. 753–770.

series does not constitute evidence of crystal differentiation. A p fectly normal variation diagram can be constructed for the hornbl dite and the rocks resulting from the transfusion of quartzite.

(12) The fact that in an association of rock types one variet chemically the equivalent of a mixture of two or more other varie does not constitute evidence that the former represents the par magma from which the other rocks arose as a result of differentiat Such evidence is adduced by Kennedy and Read (loc. cit., p. 1 to quote a recent paper, as confirmative of crystal differentiation, the case described in the present communication, the syntectic a nite, which results from the transfusion of quartzite, is chemic equivalent to a mixture of the syntectic rim-syenite and h blendite.

(13) Finally, the fact that a rock exhibits intrusive contacts shows signs of having flowed and at one time existed in wha normally regarded as a magmatic state, does not constitute evid that its magma originated in the hidden depths. Syntectic mag developed at observed levels, may give rise to rocks with just appearances, as witnessed by the pegmatite veins in the Colo hornblendite, and by the network of veins with which the latt locally dissected.

In conclusion I should like to express my great indebtednes Lady Gibbs and to thank her for her generous collaboration o chemical side.

Description of Plates XI and XII.

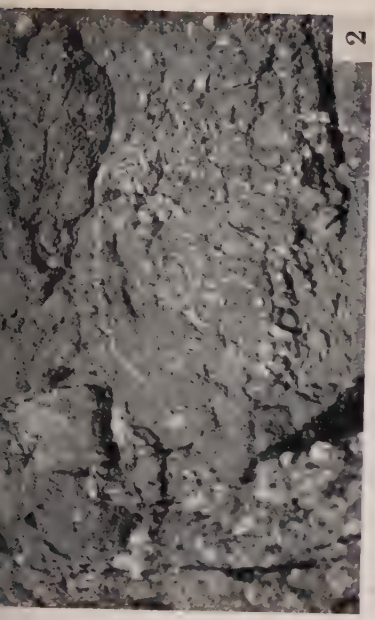
Micro-sections of rocks from Port Easdale, Colonsay, Argyllshire. (Photomicrographs, Plate XII, by G. W. O'Neill.)

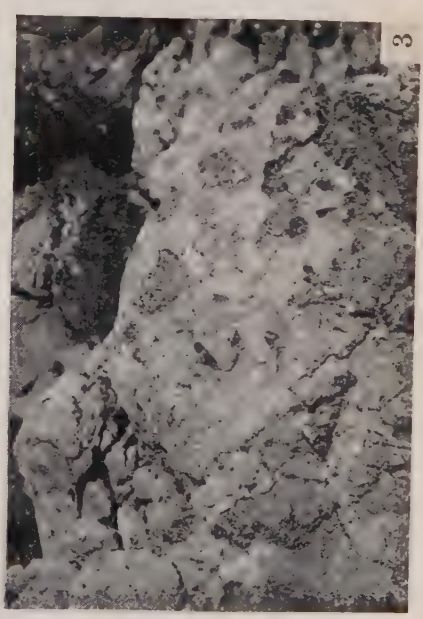
Plate XI, Fig. 1. Quartzite xenoliths with metasomatized rims in the blendite of Port Easdale. Reproduced from Plate IV of the Geology of Colo Mem Geol. Surv. Scotland, 1911, by permission of the Controller of H.M tionery Office.

Fig. 2. A felspathic tail-like vein extending from the metasomatized rim quartzite xenolith. The vein is slightly touched up, in order to ensure r duction.

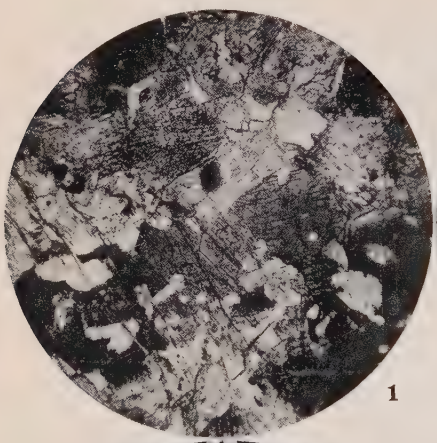
Fig. 3. Hornblendite cut by a network of leucocratic veins of syntectic o Western end of the intrusion margining the northern shore of Port Easdal

Fig. 4. Syntectic pegmatite veins developed from the felspathized marg the quartzite (back) and penetrating the hornblendite (front). Southern of Port Easdale, locality marked P on text-fig. 1.





D. L. Reynolds: Petrogenesis from Colonsay



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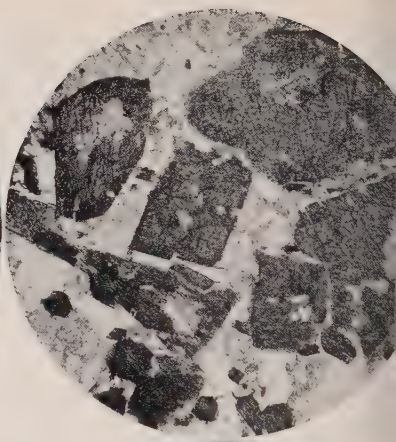

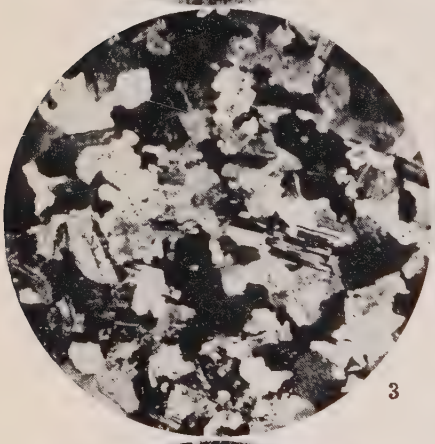

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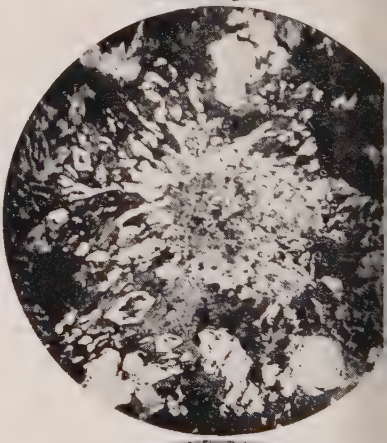

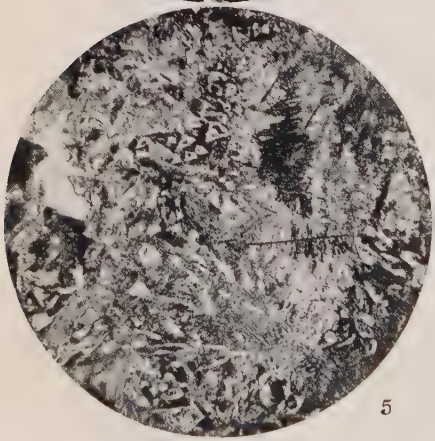

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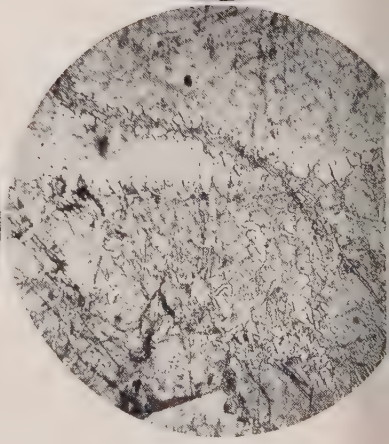

D. L. REYNOLDS: PETROGENESIS FROM COLONSAY

PLATE XII, FIG. 1. Hornblendite, showing replacement of hornblende by tremolite. Ordinary light, × 11. (See p. 377.)

FIG. 2. Syntectic appinite from a vein projecting from the metasomatized rim of a quartzite xenolith. As in the hornblendite, the hornblende is partially replaced by tremolite. Ordinary light, × 26.

FIG. 3. Syntectic syenite, metasomatized rim of a quartzite xenolith. Nicols crossed, × 15. Analysed specimen.

FIG. 4. Micropegmatite from the metasomatized rim of a quartzite xenolith. Nicols crossed, × 13.

FIG. 5. Micropegmatite, metasomatized rim of a quartzite block in the breccia which margins the intrusion to the south of Port Easdale. The needle-like mineral is rutile. Ordinary light, × 13.

FIG. 6. Contact between a residual core of quartzite and its metasomatized rim. The region of felspathization is seen to be advancing into the quartzite in minute antennae-like processes which extend along the intergranular boundaries. A felspathic vein has developed, along intergranular boundaries, in advance of the limit of general felspathization. Ordinary light, × 13.

Transfusion of quartz xenoliths in alkali basic and ultrabasic lavas, south-west Uganda.

(With Plate XIII.)

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(With micro-chemical analyses by
Friedrich Hecht, University of Vienna.)

[Read November 5, 1936.]

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I. The Problem.

THE occurrence in basic lavas of quartz xenocrysts and xenolit and the various types of reaction phenomena which they exhil have been well described by Lacroix (1893, pp. 17–48). The modifi quartz is often surrounded by a zone of pyroxene granules or pris and on the inner side of this zone the quartz may be replaced glass, both peripherally and through an anastomosing system of ve like channels. The glass may be clear or charged with gas inclusio some examples contain minute quartz-pseudomorphs after tridymi while in others microliths of alkali-felspar occur. In the basanit of Hirzstein, Hesse, nepheline occurs around quartz in place of t usual vitreous shell (Fromm, 1891, pp. 58, 65, and 70). Desp these observations, it seems to have been tacitly supposed that t glass is a more or less hydrous variety of vitreous silica. The o alternative suggestion which I have been able to trace—one wh foreshadows the results of the present investigation—was made

mpbell and Stenhouse (1907, p. 133). Referring to their observa-
n that only a thin peripheral zone of vitrification is produced
en a fused basic rock acts on a piece of sandstone in a crucible,
y write: 'This results because the alteration is due, not so much
the heat as to the acquisition of alkalies from the basic rock,
ich have acted as fluxes and converted the quartz practically into
ss.'

While investigating the lavas of Bufumbira and the melilite-rich
a of Katunga in western Ankole, I was impressed by the abundance
transfused quartz xenoliths in many of the specimens (pl. XIII,
1). The refractive index of the glass, in all the cases tested,
ved to be higher than that of any member of the opal–silica-glass
ies. The data for the three examples described in this paper are
embled in table I, together with other figures which are listed for
nparison.

TABLE I. Refractive indices of glasses.

Material.	Refractive index.	Reference.
Opal	1·41—1·46	—
Pure silica-glass ...	1·45845 (Na)	R. B. Sosman, Internat. Crit. Tables, 1929, vol. 6, p. 341.
Lechatelierite, Meteor Crater, Arizona ...	1·460 (orange-yellow)	A. F. Rogers, Amer. Journ. Sci., 1930, vol. 19, p. 197.
Silica-glass, Libyan Desert	1·4624 (Na)	L. J. Spencer, Min. Mag., 1934, vol. 23, p. 505.
Glass from transfused quartz:		
Murambite, Kigoma	1·472—1·484	
Murambite, Kigezi	1·480—1·497	
Katungite, Katunga	1·476—1·486	
Orthoclase-glass ...	1·485	G. W. Morey and N. L. Bowen, Amer. Journ. Sci., 1922, vol. 4, p. 2.
Acid obsidians ...	1·48—1·50	C. E. Tilley, Min. Mag., 1922, vol. 19, p. 278; W. O. George, Journ. Geol., 1924, vol. 32, pp. 356–357.

thus appeared that the glass from the transfused quartz might
more akin to obsidian than to silica-glass, and it therefore became
ortant to ascertain what constituents had been introduced from
lava into the quartz. The quantity of glass available in each
was so small that quantitative analysis by ordinary methods
impracticable. Fortunately, however, I was able to enlist the
peration of Dr. F. Hecht, whose skill in the technique of micro-
nical analysis is unrivalled. The methods devised by Dr. Hecht

for the analysis of the three samples of glass, checked by work
silicate powders of known composition, mark a signal advance
micro-chemical analysis. The methods, which will be described
a forthcoming paper by Dr. Hecht, have obvious applications to t
investigation of minerals when only minute quantities can be separat
in a pure state.

II. The Lavas and their Inclusions.

The Murambite of Kigoma.—Kigoma is one of the minor extin
volcanoes of Bufumbira. It is described by Combe (1933, p. 94)
a prominent truncated ash-cone situated at the foot of a ridge
Karagwe-Ankolean sediments that forms part of the eastern wall
the Bufumbira depression. The specimens investigated represe
a highly scoriaceous lava-flow which issued from a vent near t
foot of the cone.

The rock, C.2805, is coarsely vesicular and xenoporphyritic, bei
rich in fragmental forms of perfectly fresh olivine (2V *c.* 90°), ma
of which are corroded and deeply embayed. In section, simi
forms of augite are seen, together with sparse euhedral crysta
The groundmass consists of finely granular olivine, augite, and or
interspersed with minute laths of plagioclase (near An_{60}), rare ri
like specks suggestive of leucite, and a little interstitial materi
The latter contains alkali-felspar and ore-sprinkled glass which h
and there is biscuit-coloured like that generated by the transfusi
of quartz. The proportion of felsic material varies considerab
even from section to section.

The chemical composition (table II, C) shows that the rock i
melanocratic absarokite of the type for which I have proposed t
term *murambite* (Holmes and Harwood, 1936, p. 14). The analy
of the type murambite of Murambe (a breached crater $1\frac{3}{4}$ miles no
of Kigoma) is given under A for comparison.

The lava contains friable and minutely vesicular xenoliths
partially vitrified or transfused quartzite, up to 3 cm. across.
section much smaller inclusions of phyllite and granite are a
found. The quartzite and phyllite are obviously derived from
underlying Karagwe-Ankolean formations. Combe (1933, p. 9)
suggested that granitic rocks may be present in the Kigoma nei
bourhood, since the adjoining Karagwe-Ankolean rocks are loca
tourmalinized and traversed by quartz-tourmaline veins. The xe

hs confirm this inference. The quartz of the granite is transfused e that of the quartzite, but the felspar, whether perthite or oligo- se, is but little affected. The phyllite tends to be transformed o glass and grey, opaque, fibrous material consisting in part of limanite. It is hoped to investigate the transfusion of argillaceous noliths later; the present communication is confined to purely ceous xenoliths.

In section the quartzite xenoliths are found to be of three main pes: (*a*) unaltered quartzite made up of quartz grains which are her closely interlocked or cemented by a fine-grained mosaic of artz; (*b*) examples in which narrow vein-like channels of glass n a more or less uniformly distributed network (cf. pl. XIII, fig. 3); d (*c*) examples in which transfusion has spread until only rounded angular relics of quartz remain, standing out sharply in virtue of ir higher refractive index, in a continuous or vesicular base of e, cloudy, or biscuit-coloured glass (pl. XIII, fig. 6).

It is particularly notable that in any one example the glass nnels tend to be of nearly uniform width throughout, and so tributed as to subdivide the quartzite into grains of the same er of size. The channels follow, for the most part, the inter- ular boundaries, but as the transfusion develops they also verse individual grains, sometimes cutting sharply through them, metimes ending abruptly as blind, lobe-like ducts. In the last e, the proof is complete that the glass is a metasomatic replace- nt of quartz. Between crossed nicols the quartz shows no sign of in shadows such as characterize the partly felspathized quartz ins of the Colonsay xenoliths described by Doris Reynolds in the ceding paper (p. 384). This difference is probably to be correlated h the fact that glass was formed in the Kigoma xenoliths, whereas par developed directly in those of Colonsay.

Near the junction of a xenolith with the enclosing lava the ground- ss material of the latter invades the transfused channels in sinuous gues. From being nearly opaque with swarms of ore-specks, se pass rapidly into brown glass which fades imperceptibly, both rally and terminally, into the pale grey glass of the quartzite. m some examples the brown or biscuit-coloured glass of the pheral region invades the groundmass of the lava, and in the nity of such xenoliths liberated grains of quartz may be seen he groundmass. Around these the characteristic rim of augite dually develops as they float away from their source. This evidence

shows that many of the inclusions must originally have been mu larger and that the lava itself must have been modified by assimi tion of the transfusion product of quartz.

By successive separations in diluted bromoform a small samp of nearly pure glass was obtained from clean, crust-free mater broken from several of the larger white xenoliths which prelimina examination had shown to be suitable for the purpose. The separat glass was found to contain only rare traces of quartz, while in t residue the only minerals seen, besides quartz and glass, were acc sory ores and zircon. Dr. Hecht's analysis of the glass, carried o on a series of samples of about 20 mg. each (amounting in all to l than 0·2 gram) is given in table III, F; it shows that the glass essentially equivalent to a potash-rich acid obsidian.

The Murambite of Kigezi.—Kigezi is a small extinct volca $2\frac{1}{2}$ miles west-by-north of Kigoma, situated in a strike valley in Karagwe-Ankolean country on the edge of the volcanic field Bufumbira (Combe, 1933, p. 107). The lava, as represented specimen C.2817, is a dark grey vesicular rock with irregular gra of xenoporphyritic olivine and augite which vary widely in size a distribution. In section (pl. XIII, fig. 2) these minerals are seen be corroded and embayed like those of the Kigoma lava. Some the olivine xenocrysts are reduced to skeletal grids, whereas the r olivine which crystallized in the groundmass consists of min rhombic forms enclosing dense, ore sprinkled cores. Tiny spots leucite, dusky with inclusions, are easily recognized. The remain characters of the rock are like those of the Kigoma lava. B mineralogically and chemically (table II, D) the rock is a typi murambite.

Combe mentions the abundance of 'inclusions of varying size to two inches, but mostly smaller, of white silicate minerals'. specimen sent to me contains numerous white xenoliths of transfu quartzite, themselves vesicular, which range in size from fragme an inch long down to oval specks and minute relics recognizable o in thin section. Occasional bits of granite and shreds of phyl also occur. The glass immediately surrounding and cutting ac the residual quartz of the quartzites is like that of the Kigo examples, but within the more continuous areas of glass there darker streaks and patches showing flow structure. These hav refractive index up to 1·497, while that of the pale glass is 1·4 Some of the inclusions—both unaltered and transfused—cont

limanite, sometimes in interlacing wisps associated with bottle-een spinel. The glass, however, presents the same features whether limanite is present or absent.

The sample of glass analysed by Dr. Hecht (table III, G) was parated from the interior of a single xenolith about an inch across, the powder of which no sillimanite could be detected. The com-sition of the glass is closely similar to that of the Kigoma sample.

The Katungite of Katunga.—Katunga is an isolated extinct volcano northern Igara, western Ankole, situated about twelve miles SSE. the southern limit of the volcanic field south-east of the Kazunga annel, and about sixty miles north-east of the Bufumbira volcanoes ferred to above (see maps in recent Annual Reports of the Geologi-l Survey of Uganda). At Katunga, Combe (1934) discovered the st true lava flows recognized in the Toro-Ankole fields. The two ws—eastern and western—are over a mile long and consist of a k akin to potash-rich olivine-melilitite (but free from augite) for ich I have proposed the name *katungite*.[1] Katungite may be fined as an alkali ultrabasic rock with more potash than soda, the ential minerals of which are olivine and melilite; the potash may present in glass, zeolites, leucite, biotite, or potash-nepheline. jected blocks, katungite and biotite-katungite are known from eral explosion craters in the Toro-Ankole fields, while as tuffs h lapilli they are widely distributed in the same province.

At Katunga the minerals present are tabular crystals of ferric lilite (about 40 per cent.); euhedral and corroded crystals of vine (about 20 per cent.); golden brown octahedra and grains of ovskite (about 7 per cent.); and occasional grains of magnetite; an ore-sprinkled groundmass of cryptocrystalline or glassy material ich is interrupted by vesicular infillings of phillipsite, natrolite, l, possibly, ashcroftine. Leucite is rare and has been detected in y a few of the specimens. Apatite and nepheline occur as ac-sories. In both flows natrolite is most abundant near the source, responding to which the specimens from near the source are richer soda than the fully analysed specimen from near the end of the stern flow (table II, E).

Bombs of phillipsite-bearing varieties of katungite, practically free m natrolite, occur on the north face of Katunga, above the source

[1] Papers dealing respectively with the Katunga volcano and the petrology of rocks will shortly appear in the Geological Magazine by A. D. Combe and lelf.

TABLE II. Analyses of Murambite (A–D) and Katungite (E).

	A	B	C	D	E
	Murambe.	Mikeno.	Kigoma.	Kigezi.	Katunga.
SiO_2	46·78	44·74	46·70	45·20	35·37
Al_2O_3	13·24	11·82	10·86	11·26	6·50
Fe_2O_3	2·64	3·89	3·34	3·66	7·23
FeO	7·85	7·06	8·67	8·67	5·00
MgO	11·64	14·28	13·00	11·80	14·08
CaO	8·59	9·61	9·76	9·90	16·79
Na_2O	2·20	2·16	0·96	1·90	1·32
K_2O	2·72	2·51	1·56	2·02	4·09
H_2O+	0·57	0·40	0·80	0·86	2·78
H_2O-	0·26	0·10	0·10	0·06	1·15
CO_2	0·03	0·21	trace	trace	0·09
ZrO_2	trace	0·02	—	—	nil
TiO_2	2·47	2·10	2·45	2·73	3·87
P_2O_5	0·55	0·66	0·79	0·95	0·74
Cl	0·01	—	0·03	0·04	0·02
F	0·07	—	0·02	0·02	0·16
S	0·03	0·14	0·05	0·05	0·35
Cr_2O_3	0·11	—	0·16	0·11	0·01
V_2O_3	0·04	—	0·02	0·02	0·03
NiO	0·04	—	0·05	0·05	0·19
MnO	0·18	0·19	0·16	0·17	0·24
BaO	0·12	0·07	0·18	0·21	0·25
SrO	0·09	0·05	0·12	0·12	0·04
CuO	—	—	0·02	0·02	0·06
Li_2O	trace	—	—	—	nil
	100·23	100·01	99·80	99·82	100·36
Less O	0·04	0·05	0·03	0·04	0·24
	100·19	99·96	99·77	99·78	100·12

A. Murambite. C.2803. Lava of Murambe, Bufumbira, south-west Ugar Analyst, H. F. Harwood. A. Holmes and H. F. Harwood. Mem. G Surv. Uganda, 1936, no. 3, part II, p. 138.

B. Murambite. Kanemagufa valley, south of Mikeno, Birunga, Belgian Co Analyst, see under D. A. Holmes and H. F. Harwood, ibid., p. 140.

C. Murambite. C.2805. Lava of Kigoma, Bufumbira. Analyst, see under A partial analysis of another specimen by H. F. Harwood gave SiO_2 48 Na_2O 1·97, K_2O 2·74 (ibid., p. 146).

D. Murambite. C.2817. Lava of Kigezi, Bufumbira. B, C, and D are anal by Messrs. Imperial Chemical Industries (Fertilizer and Synthetic ducts) Limited, Research Department, Billingham, Co. Durham.

E. Katungite. C.4407. Near end of western lava-flow of Katunga, Bu ruguru, western Ankole, Uganda. Analyst, A. W. Groves.

Additional alkali determinations by W. H. Herdsman:

		Na_2O.	K
C.3949.	Near source, eastern flow	2·65	3
C.4412.	Near source, western flow	2·96	3
C.4411.	50 feet below source, western flow	2·91	3

he western flow. Three specimens of these are of immediate rest in containing xenoliths of biotite- and muscovite-schists, more less transfused vein-quartz, and occasional fragments of alkali-par. The source of these is clearly the Igara Schist Series (broken ough by the volcano) and the quartz and pegmatite veins seen to associated with it in the ejected blocks thrown out from the crater.

TABLE III. Micro-chemical analyses of glass from transfused quartz. (By Friedrich Hecht.)

	F Glass, Kigoma.	G Glass, Kigezi.	H Glass and quartz, Katunga.	H′ Glass alone, Katunga.
SiO_2 ...	79·99	79·68	86·35	74·51
Al_2O_3 ...	7·13	8·02	5·27	9·78
Fe_2O_3 ...	0·44	0·26	0·03	0·06
FeO ...	0·38	0·49	0·19	0·35
MgO ...	0·15	0·11	0·87	1·61
CaO ...	0·54	0·35	0·64	1·19
Na_2O ...	0·99	0·80	0·49	0·91
K_2O ...	5·53	5·76	3·32	6·16
H_2O+ ...	2·71	2·28	2·43	4·51
H_2O- ...	1·47	1·16	0·25	0·46
CO_2 ...	nil	nil	0·13	0·24
TiO_2 ...	0·78	0·14	0·09	0·17
P_2O_5 ...	0·13	0·12	nil	nil
SO_3 ...	0·87	1·13	nil	nil
MnO ...	0·48	0·17	0·14	0·26
	101·59	100·47	100·20	100·21

Glass separated from transfused quartzite xenoliths in the murambite lava of Kigoma, Bufumbira, south-west Uganda. C.2805. n 1·472—1·484. Sp. gr. 2·27—2·30 (18° C.).

Glass separated from a transfused quartzite xenolith in the murambite lava of Kigezi, Bufumbira. C.2817. n 1·480—1·497. Sp. gr. 2·30—2·33 (18° C.).

Mixture of glass (54 per cent. by weight) and quartz from a transfused vein-quartz xenolith in a bomb of katungite from the north face of Katunga, western Ankole, Uganda. C.4418.

Composition of glass alone, calculated from H. n 1·476—1·486.

ie transfused quartz has the appearance illustrated in pl. XIII, i. In some of the wider channels of glass a composite structure be detected, an inner channel with a refractive index of 1·486 g sharply separated from marginal zones, adjacent to quartz, a refractive index of 1·476. Very rarely, the place of the inner is taken by wisps of muscovite. It was found impossible to ate pure glass from the material available in sufficient quantity ven micro-chemical analysis. The material analysed by Dr. Hecht

in this case (table III, II) was found by micrometric estimation consist of approximately 54 per cent. glass and 46 per cent. qua Allowing for this, the composition of the glass is approximately given under H′.

The Katunga glass can be matched with silica-rich dopotassic a rocks (pitchstone, rhyolite, quartz-porphyry, and granite) more clos than the other two. Excess of alumina (1·16 per cent.) over amount required to make felspars is a feature which it shares w the natural rocks most like it in composition.

III. Chemistry of the Transfusion Process.

It is clear from the data presented in tables II and III that g produced by the transfusion of quartz in the examples studie neither fused silica nor a solution of silica in the material of enclosing lava. It is a metasomatic replacement-product of qu due to the introduction into the latter of various constituents in portions surprisingly different from those in which they could h been present in the magmatic part of the lava. Silica may h migrated from quartz to lava—though there is no evidence tha did so—but there is no reason to suspect that silica migrated f lava to quartz. Assuming that there was no transfer of magm silica, the average composition of the introduced material can ea be calculated. (H_2O- is omitted.)

Table IV. Composition of material introduced into quartz.

	Kigoma.	Kigezi.	Katunga.
Al_2O_3	35·65	40·65	38·05
Fe_2O_3	2·20	1·32	0·23
FeO	1·90	2·49	1·36
MgO	0·75	0·56	6·26
CaO	2·70	1·77	4·63
Na_2O	4·95	4·05	3·54
K_2O	27·65	29·59	23·97
H_2O+	13·55	11·56	17·55
CO_2	—	—	0·93
TiO_2	3·90	0·71	0·66
P_2O_5	0·65	0·61	—
SO_3	4·35	5·73	—
MnO	2·40	0·87	1·01
	100·65	99·91	98·19

The data show that in all three cases the chief materials introd were alumina, potash, and water. SO_3 was a notable contribu from murambite, while unusually high amounts of magnesia and

igrated from katungite. The variation diagram, text-fig. 1, illus-ates the differential migration of the major constituents in the atunga example, and comparison with the corresponding Colonsay agram in the preceding paper (Reynolds, p. 396) shows the essential milarity of the respective phenomena, the main difference being the

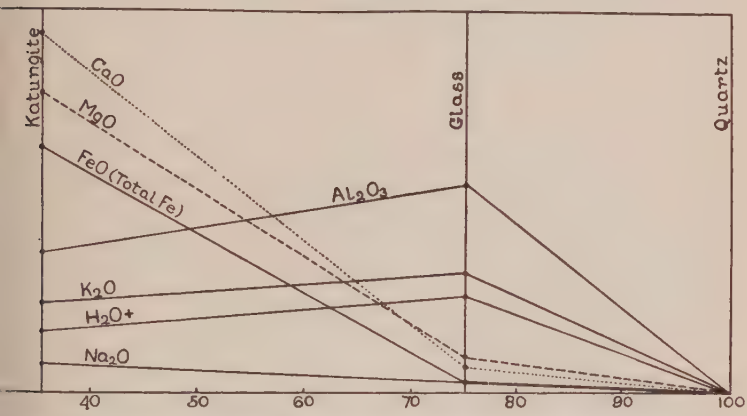

Fig. 1. Variation diagram: percentages of oxides plotted against silica.

atively feeble diffusion of soda from katungite. The formation of ss corresponds chemically to the felspathization of quartzite in onsay, while the augitic rims correspond in sequence and limited plitude of migration to the later introduction of cafemic con-uents (with production of appinite) in Colonsay.

The diffusibilities of the various constituents, judged relatively to concentrations of the latter in the respective lavas, are as follows, decreasing order of magnitude from left to right:

igoma: SO_3, H_2O, K_2O, MnO, Na_2O, Al_2O_3, TiO_2, P_2O_5, FeO, CaO, MgO.
igezi: SO_3, H_2O, K_2O, MnO, Al_2O_3, Na_2O, P_2O_5, FeO, TiO_2, CaO, MgO.
atunga: CO_2, H_2O, K_2O, Al_2O_3, MnO, Na_2O, MgO, CaO, TiO_2, FeO.

must be remarked, however, that the composition of the lavas is more than a rough guide to the composition of the magmatic erial from which the migrating emanations were actually given Moreover, as Doris Reynolds has pointed out (p. 397), there is no ence that the migrating units were oxides. The development of sfusion through and from a network of intergranular films suggests the process is one involving ionic movements and reactions along dary surfaces. Unfortunately, investigations of surface chemistry

are not yet sufficiently advanced to justify any attempt at 'explan tion'. Moreover, the products of alkali-alumina metasomatism siliceous materials are themselves so varied from one locality another—ranging from syenite to granite, micropegmatite, ar obsidian—that more exact data must be accumulated before ev empirical petrological generalizations can be attempted. Nothi can yet be profitably added to the stimulating summary of the pos bilities recently presented by Wegmann (1935).

IV. Analogous Examples.

Braefoot outer sill, Fife.—Day and Stenhouse (1930, p. 250) descri quartzite xenoliths at the top of the teschenitic sill at Braefoot Poi and state, 'Exchange of material between the fragments of quartzi and the dolerite has gone on, until the edges of the quartzite we converted into a band of igneous glass, possibly more basic externall This crystallized into a band of granular augite, inside which t less basic glass has crystallized as felspar and invades the crac in the centre core of quartzite.' After further investigation of th xenolithic horizon, Campbell and Stenhouse (1930, p. 360) find th 'The evidence indicates that, in the neighbourhood of the quartz xenoliths, there has been migration of the quartzo-felspathic mater of the middle zone, not only along fissures into the quartzite, but al out into the adjacent crystal mesh and into vesicular cavities.' The authors also point out that the phenomena conclusively demonstra 'the silicification of the Braefoot teschenite and the consequ production of a dolerite which approaches a quartz-dolerite character'. A further significant observation is made by Campb Day, and Stenhouse (1933, p. 167) in their description of the xe lithic horizon exposed along the western shore of Dalgety Bay. Th write, 'Quite frequently this outer augite zone [i.e. of the quartz xenoliths] has been disrupted, and there has been a migration of t contents of the felspathic zone, which has an "intrusive" relation the augite band.' It is abundantly proved, not only that there h been extensive assimilation of quartzite by teschenite magma, but a that, as a preliminary to assimilation, the quartz was transfused emanations from the magma to mobile material from which alka rich felspars afterwards crystallized.

Drevain, France.—In an account of the nephelinite of Dreva Saône-et-Loire, Lacroix (1903) records the felspathization of xe liths of quartz-granulite by emanations from the magma. In so

amples quartz has entirely disappeared and the inclusions are re-esented by alkali-syenite.

Karelia.—Levinson-Lessing (1935) has recently re-described a glassy va from Yalguba, Karelia, composed of varioles of acid glass in a oundmass of basic glass, both of which contain a small proportion microphenocrysts of augite. Omitting the latter, the calculated ineral compositions of the two types of glass are as follows:

Varioles.		*Groundmass:*	
Quartz	23	Olivine	24
Oligoclase	75	Bytownite	70
Magnetite	1	Magnetite	5

Levinson-Lessing suggests that after the crystallization of pyroxene e magma split into two immiscible liquids represented by the rioles and groundmass. He points out that this mechanism of ferentiation stands in contradiction to 'the generally admitted quence of events'. In the light of the Uganda evidence it seems obable that the varioles represent xenoliths which were transfused e glass by emanations from the basic magma.

Franklin district, British Columbia.—Drysdale (1915) describes from s district a Miocene intrusion in which shonkinitic pyroxenite was lowed, almost simultaneously, by syenite. He suggests that the o contrasted magmas were immiscible products of a deep-seated ferentiation of a hypothetical parental magma. In the same moir, however, he describes the formation of syenite in situ by asomatism of Lower Tertiary conglomerate and grit (p. 82). The tes illustrating the phenomena (e.g. x, xi, and xvi) show that latter are closely comparable with those of the Colonsay urrences.

Isle Cadieux, Quebec.—It is possible that the 'aplitic' inclusion scribed by Bowen (1922, p. 11) from the monticellite-alnöite of e Cadieux, near Montreal, may be partially metasomatized quartz- The composition of the 'aplite' is very like that of the trans- ed quartz from katungite (table III, H). Streaks of melilite- tite-rock occur in the alnöite and have been produced from the er by metasomatism. If the emanations responsible for this nge had acted on quartz, the 'aplite' would have been a possible duct.

Acknowledgements.—I am indebted to Mr. E. J. Wayland, Director he Geological Survey of Uganda, for the opportunity of studying

the lavas of south-west Uganda. Special thanks are due to Dr. Hecht for his micro-chemical analyses, without which no certa conclusions could have been reached. The cost of the four ne 'macro-chemical' analyses was defrayed out of a grant from Mess Imperial Chemical Industries Limited (Research Department) whi is gratefully acknowledged.

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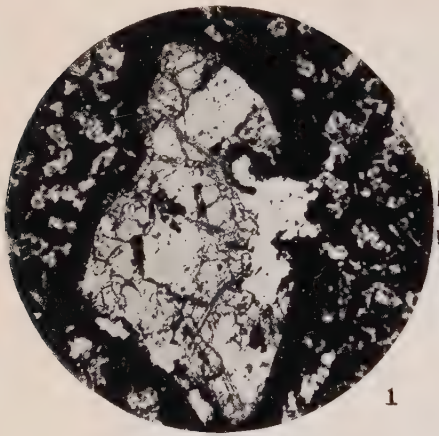
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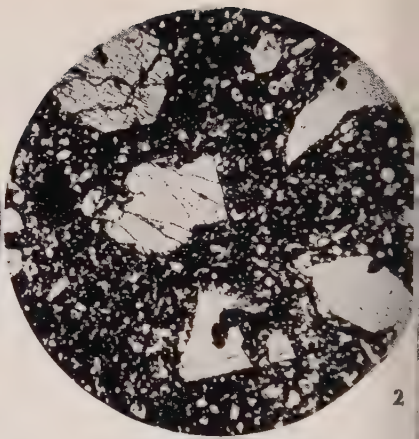
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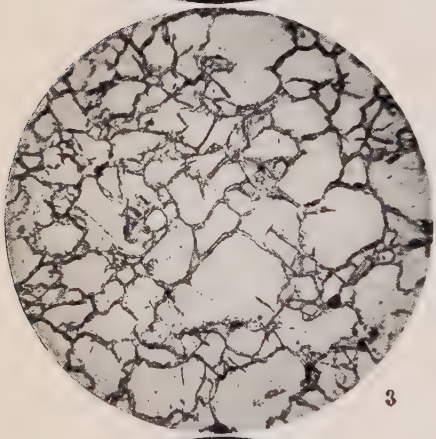
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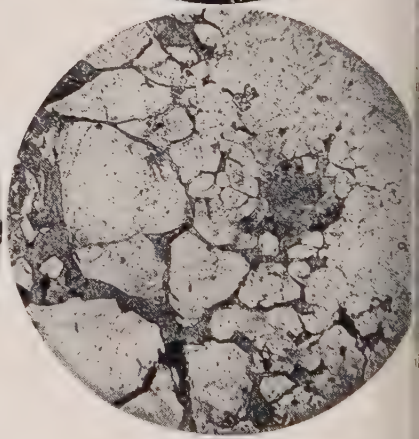

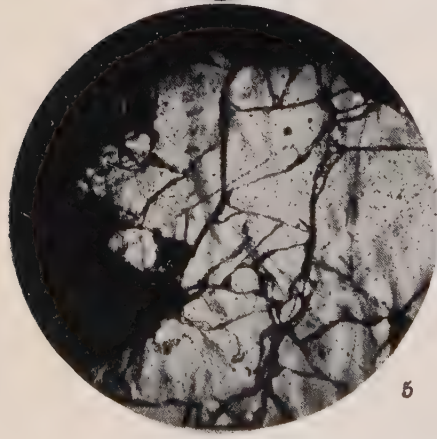
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ARTHUR HOLMES: TRANSFUSION OF QUARTZ.

VII. Description of Plate XIII.

icro-sections illustrating transfusion phenomena from Uganda and Colonsay.

(Photomicrographs by G. W. O'Neill.)

ig. 1. Transfused quartz xenocryst in kivite (a variety of leucite-basanite), bungo volcano, Bufumbira, south-west Uganda. C.2836. The xenocryst is nged with a dense criss-cross felt of green augite needles, which appears as a ck border in the figure. Towards the periphery the needles are radially dis-buted and merge without a break into the fawn prismoids of the groundmass gite. On the inner side of the augitic border the needles become less crowded d are embedded in glass of pale buff colour. The interior of the xenocryst is de up of pale biscuit-coloured glass which surrounds and cuts through relics quartz, all of which are in optical continuity. × 31.

ig. 2. Murambite lava of Kigezi, Bufumbira. C.2817. Showing xeno-phyritic olivine and augite in a groundmass of olivine, augite, plagioclase, cite, and ores. × 12½.

ig. 3. Transfused vein-quartz from a xenolith in katungite (potash-rich ite-free olivine-melilitite), Katunga, 60 miles north-east of Bufumbira. 418. In addition to the intergranular film of glass, vein-like and tubular nnels of glass cut across individual crystals, while others terminate within gle crystals (e.g. the tack-shaped example to the right of the centre of the d) without distorting them, thus showing that the process of transfusion is e of replacement. × 23.

ig. 4. Felspathized quartzite in hornblendite, Port Easdale, Colonsay. wing contact between a residual core of quartzite (right) and its metasoma-d rim. The felspathized channels extend and develop along the intergranular ndaries of the quartzite and here and there traverse individual grains. Com-e with fig. 3. × 29.

ig. 5. Transfusion of a single grain of quartz from a xenolith in murambite, gezi, Bufumbira. C.2817. The channels and the continuous area of glass ear black in the figure. Notice the metasomatic granulation of the quartz in, the separated parts of which remain in optical continuity. Crossed nicols. 23.

ig. 6. Transfused quartzite xenolith in murambite, Kigezi, Bufumbira. 817. Most of the relics of quartz belong to what were originally three indi-ual grains, the separate parts of which still remain in perfect optical con-uity. The elongated group of eight relics on the right of the field represent such grain. Crossed nicols. × 23.

The paragenesis of kyanite-eclogites.

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[Read June 25, 1936.]

In Haüy's original definition of eclogite [1], the presence of kyani as an accessory constituent was recognized, and it is appare that he was familiar with examples from the Sau Alps and Styri The best known of eclogites—those of the Bavarian Fichtelgebir (e.g. Silberbach, Weissenstein, and Eppenreuth)—contain significa kyanite interspersed among the omphacite grains or associated wi accessory quartz and muscovite in the rocks. Of these rocks rath extended descriptions have been published [2]. Analyses of t minerals and the rocks themselves belong to an early date and do n reach the standard of modern analyses. Later, Düll (1902) [published a systematic account of these Bavarian eclogites and h added an analysis of an eclogite with kyanite from Unterpferdt ne Silberbach and an analysis of a garnet from a Silberbach eclogite.

Kyanite-eclogites are also known from Alpine regions, from t Bachergebirge (Yugoslavia) [4], Sau Alps (Carinthia) [5], Oetzth (Tirol) [6], Kor Alps (Carinthia and Styria) [7], Graian Alps (Italy) [8 and several regions in France [9].

An important contribution to our knowledge of the compositi of the kyanite-bearing eclogites has been made by Mlle Brière [9] her memoir on the French eclogites. Still later a summary of t eclogites (or griquaites) of South Africa and Tanganyika has be given by Williams [10] in his book 'Genesis of the Diamond' Among these, kyanite-eclogites are recorded and new analyses a available. Despite these contributions, the significance of kyani in eclogites remains a matter for further inquiry, though Eskola [1 in his discussion of the eclogite facies has commented briefly on t relationships of the kyanite-bearing varieties of this rock.

The typical Fichtelgebirge eclogites (Silberbach and Weissenstei consist essentially of omphacite, garnet, and kyanite with accesso quartz, rutile, zoisite, iron ores, and white mica. In the discussi

t follows, attention will be focused particularly on eclogites of s type poor in such minerals as amphibole or zoisite.

The ordinary pyroxene-eclogite may be considered as essentially imineralic rock composed of garnet and omphacite. To discuss paragenetic relations of these and kyanite-bearing eclogites knowledge of the composition of the constituent minerals is

TABLE I. Analyses of pyroxenes from eclogites.

	1.	3.	20.	W.	6.	2.	9.	8a.
...	54·49	55·56	52·82	54·48	54·21	54·03	53·48	54·88
...	2·50	7·17	6·42	8·20	10·91	11·54	9·52	10·44
...	1·63	2·82	2·30	0·48	3·12	5·62	3·00	5·80
...	trace	0·15	0·25	0·57	0·46	0·54	1·04	0·39
...	1·98	2·06	3·07	1·23	1·33	4·09	5·84	3·31
...	0·06	0·05	0·03	0·02	—	0·05	—	—
...	16·74	11·32	13·49	12·72	10·03	5·13	6·34	6·41
...	21·40	16·85	19·06	19·40	14·61	11·82	14·87	12·94
...	0·83	3·92	1·82	2·88	4·51	6·81	3·97	5·31
...	0·40	0·57	trace ?	0·10	0·92	0·20	0·63	0·34
+ ...	0·12	0·08	0·48	nil	—	0·29	0·73	0·23
− ...			0·15	nil	0·05		nil	—
	100·38	100·55	99·89	100·08	100·15	100·12	99·42	100·05

Almklovdalen, Norway ([12], p. 28); also Cr_2O_3 0·20, NiO 0·03. 3. Silden, way ([12], p. 38). 20. Hurry Inlet, Greenland ([13], p. 19). W. Weissen- Bavaria (new analysis). 6. Burgstein, Tirol ([16], p. 447). 2. Vanelvs- n, Norway ([12], p. 32). 9. Glenelg, Scotland [14]. 8a. Fay, France p. 92).

ntial. As regards kyanite-free eclogites analyses are available the constituent garnets and pyroxenes of specimens from the wing localities: (*a*) Almklovdalen, (*b*) Vanelvsdalen, (*c*) Silden rway) [12], (*d*) Burgstein (Oetzthal) [6], (*e*) Hurry Inlet (east enland) [13]; and single analyses of garnets or pyroxenes are rded from eclogites of Fay (pyroxene) [9], Glenelg (pyroxene) [14], net) [15].

rom kyanite-eclogites, no modern analyses of their contained xenes are available, but of their garnets we have analyses from ite-eclogites from St. Philbert de Grandlieu [9] and Silber- [3]. To obtain further data, new analyses have been made of et and pyroxene from a kyanite-eclogite from Weissenstein[1] e probably Silberbach ?), Fichtelgebirge, Bavaria.

[1] his specimen from Krantz is labelled 'Weissenstein', but it shows great rity to the well-known eclogite from Silberbach—particularly in the el orientated silky lustred omphacite (cf. descriptions by Düll [3], p. 141).

The comparatively simple mineral composition of the typi eclogite suggests that some correlation between the compositions the two essential minerals—pyroxene and garnet—might be esta lished by comparison of a series of analyses. With this purpose view the analyses of the pyroxenes of eclogites of which the compo tions of the associated garnet are known, are tabulated on p. 423. T further analyses of eclogite pyroxenes are given under 9 and 8 a.

These analyses though showing a considerable variation in alum content have uniformly a high silica content. It is clear that major part of the Al replaces metals in the structural formula of pyroxene and only a small fraction replaces silicon.

The new analysis of pyroxene from the Bavarian eclogite in tab (W) can be interpreted as follows:

	%	Metal atoms on basis of 6 oxygen atoms.		
SiO_2	54·48	1·94		
Al_2O_3	8·20	0·34	0·06 / 0·28	2·00
Fe_2O_3	0·48	0·01		
TiO_2	0·57	0·02		1·03
FeO	1·23	0·04		
MnO	0·02	—		
MgO	12·72	0·68		1·97
CaO	19·40	0·74		
Na_2O	2·88	0·20	0·94	
K_2O	0·10	—		
	100·08			

Analyst, Miss Hilda Bennett.

The properties of this pyroxene are specific gravity 3·30, α 1·6 β 1·680, γ 1·694, $\gamma : c = 43°$, $2V_\gamma$ 64°.

The composition of the garnet associated with this pyroxen given on p. 425.

Before a comparison of these pyroxenes and their associated gar is instituted it is of importance to note their associated mine Eclogites 1 and 3 are practically bimineralic, containing only ac sory quartz, rutile, and a little white mica. Eclogite 20 cont some hornblende partly as fringes to the garnet and a little s plectite associated with the pyroxene. Eclogite W, besides acces quartz, rutile, and iron ores, contains a small amount of β-zoisite significance of which will be discussed later. Eclogite 6 cont some hornblende and a little diopside-plagioclase symplectit from the omphacite. Eclogite 2 has only accessory apatite,

s, rutile, and diopside-plagioclase symplectite. It appears a sonable assumption that the development of small amounts of rograde hornblende as fringes to the pyroxene and garnet of these gites has not affected the compositions of the fresh garnets and oxenes which have been subject to analysis.

Analysis of garnet from eclogite from Weissenstein, Bavaria.

	%		Metal atoms on basis of 12 oxygen atoms.	
SiO_2	39·64	2·92		3·00
Al_2O_3	24·19	2·09	0·08	2·01
Fe_2O_3	1·15	0·06		
TiO_2	0·26	0·01		
FeO	13·63	0·84		2·98
MnO	0·33	0·02		
MgO	12·90	1·42		
CaO	7·98	0·63		
H_2O+	nil			
H_2O-	0·08			
	100·16			

Sp. gr. 3·760, n 1·756.

Analyst, Miss Hilda Bennett.

he following list presents the compositions of the garnets asso- d respectively with the pyroxenes (1–2) of table I. The com- ition is given in terms of the divalent elements (molecular) without ard to the trivalent elements.

$Fe_{26}Mn_1Mg_{61}Ca_{12}$.	W. $Fe_{28\cdot7}Mn_{0\cdot7}Mg_{48\cdot9}Ca_{21\cdot7}$.
$Fe_{40}Mn_2Mg_{43}Ca_{15}$.	6. $Fe_{42\cdot5}Mg_{35\cdot3}Ca_{22\cdot2}$.
$Fe_{27\cdot6}Mn_{0\cdot3}Mg_{51}Ca_{21}$.*	2. $Fe_{57}Mn_2Mg_{16}Ca_{25}$.
$Fe_{37\cdot4}Mn_{1\cdot5}Mg_{41\cdot8}Ca_{19\cdot3}$.	7. $Fe_{38}Mg_{34}Ca_{28}$.

n addition to these six analyses, the figures for two other garnets n eclogites are given in the list: 9 a (Glenelg) and 7 (St. Philbert randlieu). Of other available garnet analyses reference may be e to Philipsborn's data [16]—stated in the form of molecular entages—the original detailed analyses having apparently not published. They are as follows:

clogite, Zöblitz (Erzgebirge)—garnet $(Fe,Mn)_{24}Mg_{60}Ca_{16}$.
clogite, Böhrigen (Saxony)—garnet $(Fe,Mn)_{41\cdot5}Mg_{31}Ca_{27\cdot5}$.
clogite, Weissenstein (Bavaria)—garnet $(Fe,Mn)_{49\cdot5}Mg_{20}Ca_{30\cdot5}$.

nalysis of this garnet shows a figure of 6·02 % Fe_2O_3 and offers some ilty in structural interpretation.

It may be noted here that several of these garnets lie outside
field of miscibility in the system almandine-pyrope-grossular
deduced by Boeke [17] in his statistical study of garnet analy
Heritsch [18] has recently analysed a garnet (not of eclogitic pa

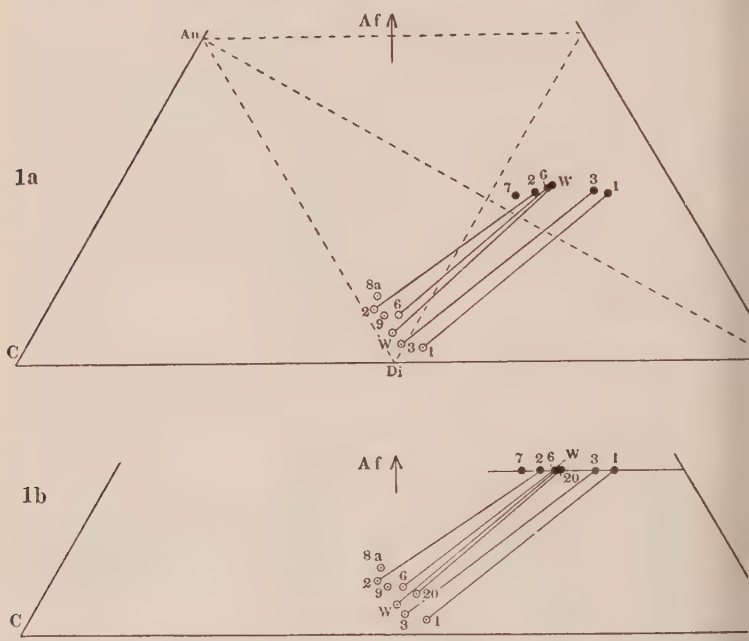


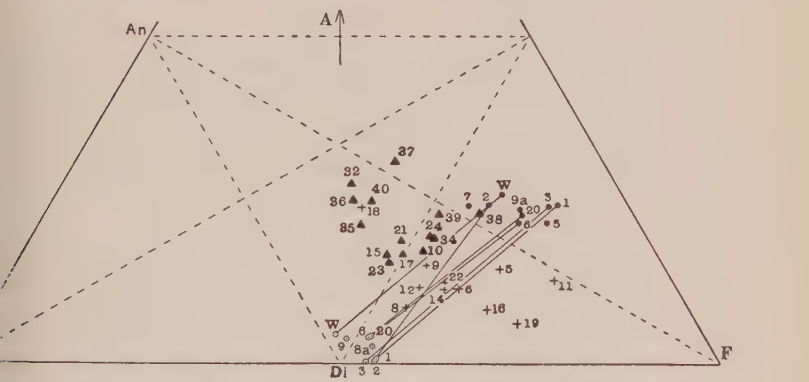
Fig. 1. Triangular plot of chemical analyses of garnets (black dots)
associated pyroxenes (ringed dots) from eclogites.

genesis) which lies still farther from the miscibility field given
Boeke.[1] This garnet, whose composition is $(Fe,Mn)_{45\cdot5}Mg_{7\cdot6}Ca$
occurs in druses associated with quartz, calcite, and felspar at
junction of pegmatite with garnet-gneiss, amphibolite, and au
garnet skarn (pseudo-eclogite) at the Lieserschlucht, Spittal on
Drau (Carinthia) (cf. H. Wieseneder, Tschermak's Min. Petr. M
1935, vol. 46, p. 185).

The relations between the compositions of the garnets and
associated pyroxenes can be appreciated if the analyses are plo
in a triangular diagram. In fig. 1 a the analyses are plo

[1] The miscibility gap between grossularite on the one hand and py
almandine-spessartite on the other from Boeke's data is given as 20-
MO (= MgO + FeO + MnO) where CaO + MO = 100. [17], p. 157 and fig. 2.

an Af–F–C. diagram, where Af = $Al_2O_3 + Fe_2O_3 - (Na_2O + K_2O)$, = $(FeO + MgO + MnO + TiO_2)$, and C = CaO, all expressed in mole- r numbers. In fig. 1 b the plot is identical except that the com- tions of the garnets are expressed in terms of (Fe,Mn,Mg) : Ca g the theoretical grossular–(almandine-pyrope) join.



c. 2. Triangular plot of chemical analyses of kyanite-eclogites (black gles) and kyanite-free eclogites (crosses).

e numbers refer to rocks from the following localities: Norway, 5, 11, a) [12]; Greenland, 19, (Sahlstein) [13]; France, 8, 12, 14, 15, 16, 17, 18, 2. 23, (Brière) [9]; Tirol (Oetzthal), 6, 10 (? kyanite type , (Hezner) [6]; elgebirge, 24, (Düll) [3], 40 (new analysis); Glenelg, Scotland, 9, (Alderman) Tanganyika, 32 (Williams) [10]; South Africa, 34, 35, 36, 37, 38, 39, iams) [10].

her numbers refer to minerals (cf. fig. 1 and table I).

he *paragenetic conjugation-lines* in the diagram indicate clearly sympathetic variation of the two constituents of the several gites. Of these series of analyses only that of the Bavarian gite (W) represents a garnet-pyroxene assemblage with kyanite. diagrams do not, however, make clear the chemical factor which ay be supposed leads to the appearance of kyanite in the mineral mblage.

ne conjugation-lines of eclogites (2) and (6) have a position nd that of the kyanite-eclogite (W), and in addition the solitary xene analyses (8 a) and (9) occupy a similar position (cf. b).

spection of the omphacite analyses of table I shows, however, the extreme positions of these points and lines is controlled by Fe_2O_3 content of the minerals, as the following figures show :

	Per cent. Fe_2O_3 in garnet.	pyroxene.
W	1·15 ...	0·48
2	1·80 ...	5·62
6	5·45 ...	3·12
9	— ...	3·00
8a	— ...	5·80

The plotting of Fe_2O_3 as a separate component in a quatern system would leave the position of the WW conjugation-line li affected owing to the low values of Fe_2O_3 in the analyses, but position of conjugation-lines (2) and (6) would be materially placed, as may be readily seen by constructing such a tetrahed plot.

A ternary diagram in which Al_2O_3 is plotted separately from Fe, though not rigorous in its application, may serve to illustrate importance of Al_2O_3 content in determining the presence or abse of kyanite in the eclogite assemblage.

The same analyses are plotted in fig. 2 where the value A is r $Al_2O_3 - (Na_2O + K_2O)$, and Fe_2O_3 (expressed as mols. FeO) is ad to FeO and plotted with it as F.

The position of the paragenetic conjugation-line for the Bavar eclogite (W) now emerges beyond those of the other eclogites, as extreme boundary, owing to the low content of Fe_2O_3 in its pyrox compared to the pyroxenes (2) and (6).

Among the listed pyroxenes (2) is exceptional in its high N and Fe_2O_3 character. The construction of the plot assumes removal of Al_2O_3 selectively with Na_2O as jadeite, leaving li excess Al_2O_3. The relations envisaged would still be maintai were a proportion of Na_2O removed with Fe_2O_3. In this conne the limited field of existence of jadeite (as a high-pressure mine contrast acmite) should be remembered. As indicated in a l paragraph little study has as yet been made of the paragenesis chloromelanite and jadeitic pyroxenes.

Inspection of this plot leads to the suggestion that the appeara of kyanite as a mineral phase in an eclogite results from the pres of alumina in excess of that amount which can be incorporate the bimineralic pyroxene-garnet assemblage.

This suggestion can be further tested if the analyses of eclogi including kyanite-eclogites, are plotted in the diagram. In reca lating the modern analyses to the co-ordinates of the plot accesso

h as apatite, rutile, magnetite, and ilmenite, have been allowed wherever possible by subtracting the equivalent amount of CaO P_2O_5 in the analyses, and FeO, Fe_2O_3, and TiO_2 where modes ve been given.

The resultant points are given in the diagram (fig. 2). The plotted sitions of the kyanite-eclogites are seen to fall above the para- netic conjugation-line for the Bavarian eclogite (W), while those kyanite-free eclogites fall below it.

It is clear that only those analyses should be plotted the rocks of ich contain preponderant pyroxene and garnet with or without nite. The presence of notable quantities of plagioclase (anorthitic) zoisite in an eclogite may cause its plotted position to fall within region of the kyanite-eclogites. Such is the case with eclogite 18 edpain [9], p. 172) rich in zoisite and free from kyanite.

The position of the pyroxene-garnet conjugation-line is clearly endent on the chemical composition of the rock, but the critical jugation-line for the entry of kyanite may be expected to vary h the physical conditions (pressure and temperature) under which eclogite has crystallized.

Here it is important to note the minerals associated with garnet pyroxene. The Bavarian kyanite-eclogite (W) of which analyses garnet and pyroxene have been made, contains in addition, as ady mentioned, a small amount of β-zoisite. Though there is no cation that the zoisite is developing from either garnet or pyroxene, s conceivable that in a higher grade facies the constituents of ite would be represented in the composition of the garnet and oxene. In such a case the position of the critical conjugation-line zoisite-free eclogite would lie still farther towards the CaO–Al_2O_3 ndary of the figure.

The occurrence of garnets with high lime values in kyanite-eclo- s—e.g. 7 of fig. 2 from the kyanite-eclogite of St. Philbert de ndlieu—is perhaps to be interpreted in this light.

Nature of kyanite-eclogites.—In table II is given a new analysis of yanite-eclogite from Weissenstein. The constituents are omphacite, net, kyanite, some β-zoisite, and accessory rutile, magnetite, rtz, and muscovite. A significant feature is the high content of mina. Its plotted position in fig. 2 lies well beyond the extreme net-pyroxene conjugation-line. Subtraction of the small amount -zoisite would not affect appreciably its plotted position.

n table II this eclogite is compared with basic igneous rocks of

similar chemistry. In general the compositions of kyanite-eclogit fall within the triangle diopside-anorthite-F (hypersthene, olivi iron ores); thus clearly in the field of igneous rocks, like the kyani free eclogites. They extend, however, farther in this field towar the anorthite apex.

TABLE II. Analysis of kyanite-eclogite (with other rocks for comparison).

	1.	2.	3.	4.	5.
SiO_2	50·75	48·34	47·28	50·80	48·02
TiO_2	0·12	0·95	0·28	0·43	0·23
Al_2O_3	20·02	20·10	21·07	19·42	20·01
Fe_2O_3	0·42	1·97	3·52	0·97	1·13
FeO	3·87	6·62	3·91	6·67	7·29
MgO	9·34	5·49	8·06	5·78	10·05
CaO	13·07	13·16	13·42	12·68	11·42
Na_2O	1·14	1·66	1·52	1·60	0·51
K_2O	0·15	0·98	0·29	0·37	0·05
H_2O+	0·70	0·44	0·53	0·86	0·57
H_2O-	0·50	0·02	0·13	0·25	0·10
P_2O_5	trace	0.04	trace	—	trace
MnO	0·05	0·32	0·15	—	0·18
CO_2	nil	0·11	—	—	0·25
&c.	—	0·10	0·04	0·01	0·17
	100·13	100·30	100·20	99·84	99·98
Sp. gr.	3·386	—	2·90	—	2·98

Norm of (1)

Quartz	1
Orthoclase	1
Albite	9
Anorthite	48
Diopside	12
Hypersthene	23
Ilmenite	0
Magnetite	0

(II) 3. 5. 5. 0.
Anorthite conten
normative pla
clase 83·0 %.

1. Kyanite-eclogite, Weissenstein, Fichtelgebirge, Bavaria. Analyst, W. Herdsman.
2. Gabbro, Leac an Leathaird, Mull. (Washington's Tables, 1917, p. 538.
3. Olivine-gabbro (eucrite), Coir' a' Mhadaidh, Skye. (Ibid., p. 538.)
4. Quartz-diabase, Kerr Lake mine, Cobalt, Ontario. (Ibid., p. 528.)
5. Norite, McKinsley's mill, Cecil Co., Maryland. (Ibid., p. 666.)

In the language of the norm the appearance of kyanite in eclogi is favoured by high normative anorthite. Their analyses can matched with those of eucrites, hypersthene-gabbros, norites, a some quartz-dolerites thus typically with rocks which in Hebridean region would be described as of porphyritic cen magma type.

It is worthy of remark that sillimanite has been recorded o rarely as a constituent of eclogites. The observation of Willia ([10] vol. I, p. 334) that the Tanganyika eclogites carry sillima as well as kyanite is remarkable and these eclogites are clearly wor of further study in this connexion. Normally under the conditi of crystallization of eclogites—whether primary or metamorphi

he pressures seem to have been sufficiently high to give the densest orm of aluminium silicate.

Chloromelanitites and Jadeitites.—Hezner [6] and Eskola [11] have ointed out that a close relation exists between eclogites, chloro-elanitites, and jadeitites. These latter rocks are much richer in yroxene and consist at times almost wholly of pyroxene with only ccessory minerals including garnet. Rocks of this type containing arnet deserve a much closer study than has yet been devoted to hem. The work of Franchi [8] has shown that chloromelanite-rocks ccur in some abundance in the Graian Alps. As examples may be aken the jadeite-rock (in the form of a stone axe) described by Iezner from Schaffis, Bieler See, Switzerland, and a chloromelanite-ock from Oropa, Biella, Piedmont, referred to by Franchi.

The plots of the analyses of the pyroxenes of these two rocks depart onsiderably from the plotted positions of the pyroxenes discussed in his paper. The Schaffis specimen (analysis conducted on not quite ure material) has co-ordinates A 29·2, F 35·3, C. 35·4, thus falling bove the grossular-almandine join, while the pyroxene of Oropa ils inside the triangle (CaO-diopside-anorthite). The compositions f their associated garnets is unknown. Closer examination of such ssemblages in view of the possible miscibility gap in the garnet olid-solution series should prove an instructive paragenetic study. o these problems I hope to return later.

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An occurrence of greenalite-chert in the Ordovician rocks of the southern uplands of Scotland.

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[Read November 5, 1936.]

ROCKS composed mainly of the hydrated ferrous silicate greenalite are of very restricted geological and geographical distribution and, up to the present, have been recognized only from certain the pre-Cambrian sedimentary iron-bearing formations of the Lake perior region.[1] It is of interest, therefore, to record an additional currence, not only from another region but from a later geological stem.

The material to be described in the present paper was collected by R. Eckford from the Arenig outcrop near Glenluce, Wigtownshire, ere it occurs in association with spilitic pillow-lavas and basic bbroic intrusions. In hand-specimen the rock is dark greenish-black colour and weathers with a deeply iron-stained crust. It has a ghtly brecciated appearance and the granular nature is quite apparnt with the aid of a lens.

Under the microscope it presents a very characteristic appearance, d is found to be composed of numerous little, rounded, ellipsoidal slightly irregular granules of a greenish mineral, sometimes partly wholly replaced by spherulitic aggregates of dusty quartz, embedded a fine-grained or somewhat variable matrix of cherty silica. The anules are separated from the cherty base by a narrow rim of dusty rbonate (chalybite), and this substance apparently gives rise also to e dusty staining of the secondary quartz aggregates.

The greenalite itself varies considerably in its properties. In thicker rtions of the slice it is dark and opaque, quite isotropic, and greenish reflected light. Here and there it is associated with some replacing

[1] C. R. Van Hise and C. K. Leith, The geology of the Lake Superior region. nograph U.S. Geol. Surv., 1911, no. 52. C. K. Leith, R. J. Lund, and Leith, Pre-Cambrian rocks of the Lake Superior region. Prof. Paper U.S. ol. Surv., 1935, no. 184.

magnetite. In thinner sections it is usually olive-green or less co
monly brownish-green in colour and under crossed nicols exhibits
mottled patchy appearance due to an intimate mixture of isotrop
and anisotropic portions. Under high powers the anisotropism m
be seen to result from alteration of the isotropic granules to extreme

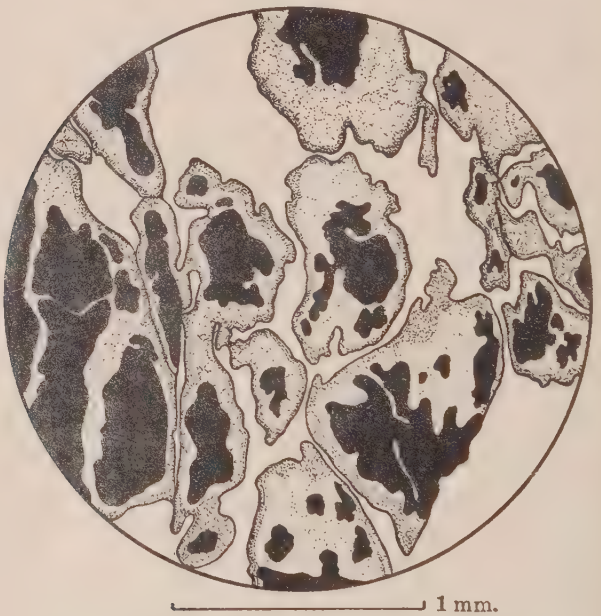

Fig. 1. Greenalite-chert from Glenluce, Wigtownshire. Greenalite (blac
undergoing replacement by dusty quartz aggregates.

fine-grained fibrous aggregates of some greenish, slightly pleochr
mineral. The presence of the latter imparts a slight aggregate pl
chroism which is occasionally marked in shades of olive-green
brown. There can be small doubt regarding the identity of the an
tropic portions with metagreenalite,[1] and although the materia
too fine-grained to permit of definite optical determination, the p
chroism and general nature is suggestive of grunerite.

The isotropic granules are homogeneous and usually show nar
irregular cracks similar to the shrinkage cracks in gels. They v
found to have a refractive index of about 1·675, and this value i

[1] F. Jolliffe, A study of greenalite. Amer. Min., 1935, vol. 20, pp. 405-
[Min. Abstr. 6–151.]

rfect agreement with the determinations made by Jolliffe on material m the Biwabik formation of Minnesota.[1]

Characteristically the granules are seen to be undergoing replace- nt by dusty quartz in the form of fine crystalline aggregates or nerulitic growths, and this silicification appears to lead ultimately the production of the spherulitic cherts found here and there roughout the Southern Uplands. All stages in the replacement and rystallization may be traced, but it is not known whether the ocess dates from the period of formation of the rocks or took place bsequently.

A typical specimen of the greenalite-chert has been analysed by W. J. Skilling, to whom the writer is much indebted, and the ults are set out below.

SiO_2	71·08
TiO_2	0·13
Al_2O_3	0·55
Fe_2O_3	0·78
FeO	18·53
MnO	nil
MgO	0·18
CaO	trace
CO_2	0·44
Loss on ignition ...	6·40
Not determined ...	1·91
Total...	100·00

s seen from this analysis that the green granular mineral must be ntially a pure hydrated ferrous silicate similar to the greenalite the Mesabi range which has been shown by Leith[2] and Jolliffe . cit.) to be a definite mineral species approximating to the com- ition $2H_2O.3FeO.4SiO_2$. It is unfortunate that the writer has been ble to obtain any of the Biwabik material for comparison, but the thin sections of the Glenluce rock are identical with the examples red by Van Hise and Leith.[3]

lthough the Scottish occurrences of greenalite-rocks have not yet n studied in detail, we may consider briefly certain of the genetical cts of the problem.

he iron formations of the Lake Superior region now consist mainly anded jaspers and ferruginous cherts derived from the oxidation

[1] F. Jolliffe, loc. cit., 1935, p. 410.

[2] C. K. Leith, The Mesabi iron-bearing district of Minnesota. Monograph U.S. Geol. Surv., 1903, no. 43, pp. 102–116.

[3] C. R. Van Hise and C. K. Leith, loc. cit., 1911, pls. XXXVII and XLIII.

of primary banded siliceous iron carbonate and greenalite-rocks, a the deposits as a whole represent chemical or in small part biochemic sediments. It is now unanimously agreed that the precipitation h been effected through the agency of inorganic processes, and Leit succeeded in producing a precipitate similar to greenalite in co position and structure by a reaction involving alkaline silicates a ferrous salts. The main problem of the sedimentary iron formatio however, concerns the origin of the solutions from which these va bodies of silica and iron were produced. Certain geologists belie that the iron and silica in solution were derived by intensi weathering of basic igneous rocks.[2] The difficulty in this case is th under such circumstances the iron is all in the ferric state and t precipitation of greenalite would necessitate reduction on a vast sca If, however, the solutions derived their iron and silica directly fr magmatic sources, either by magmatic emanations from igneous roc poured out on the ocean floor or by rapid decomposition of ba igneous rocks due to their contact while hot with sea-water, the di culty would not arise. Furthermore, there is a close association such iron formations with contemporaneous submarine lavas and t feature affords additional evidence in support of the latter theo which is the one held by the majority of investigators.

The cherts and related rocks associated with the Arenig pillo lavas of the Southern Uplands have usually been regarded as t radiolarian cherts formed by organic agencies, but the occurrence greenalite in the Glenluce district and the abundance of ferrugin cherts and even small deposits of haematite on this horizon throu out the Southern Uplands suggests that chemical agencies simila those which operated in the Lake Superior region may have playe greater part than has hitherto been suspected. Finally, the asso tion of the greenalite-rocks with the Arenig pillow-lavas in Wigto shire is at least suggestive that the iron and silica in question been derived from igneous emanations rather than by processe weathering.

[1] C. K. Leith in The geology of the Lake Superior region. Monograph Geol. Surv., 1911, no. 52, pp. 521–529.

[2] J. W. Gruner, The origin of sedimentary iron formations. Econ. Geol., 1 vol. 17, pp. 407–460. [Min. Abstr. 3–136.]

MINERALOGICAL ABSTRACTS

(Vol. 6, No. 8, December, 1936.)

Notices of Books.

ONSDALE (Kathleen). *Simplified structure factor and electron density formulae for the 230 space groups of mathematical crystallography.* London (published for the Royal Institution by G. Bell & Sons), 1936, [vi]+181 pp. 4°. Price 10*s*.

This book, intended solely for the research worker in crystal-ucture, extends and simplifies the generalized formulae given in e International Tables for the determination of crystal-structure .A. **6**–145] for direct use. A supplement at the end of the volume es the alternative co-ordinates and formulae for those space-groups which an origin other than the centre of symmetry is usually osen. By photographic reproduction of the author's script the t of printing has been reduced and printer's errors eliminated.

F. A. B.

ERSMAN (A. E.)] Ферсман (А. Е.). Геохимия. Том I (второе издание). [*Geochemistry.* Vol. 1 (second edition).] Госхимтехиздат [Goskhim-tekhisdat], Leningrad, 1934, 324 pp., 40 figs. Price 4r. 50k. (bound 5r. 50k.).

This is the second edition, corrected and rearranged, of the volume blished in 1933 [M.A. **5**–433]. The appearance of this work rks the transition from the 'data' to the 'science' of geo-mistry. The object of geochemistry, as defined by the author, the study of the laws of distribution and migration of the chemical ms-elements'. In Chapter I the scope and the methods of geo-mistry are outlined, together with an historical sketch and the iern aspect of this science. In Chapter II an account is given of theories of atomic structure, isotopes, valency, crystal-chemistry, isomorphism. In Chapter III the average composition of the spheres, meteorites, and cosmic bodies are given and discussed. reat use is made of the new method in using the diagrams of kes [M.A. **6**–286]. In Chapter IV the study of the geospheres is ied to greater detail and certain geochemical laws are discussed. t text of the book is supported by numerous tables, diagrams, ographical lists, and detailed indexes. S. I. T.

A.—Y

[Fersman (A. E.)] Ферсман (А. Е.). Геохимия. Том II. [*Geochemist*
Vol. 2.] Химтеорет [Khimteoret], Leningrad, 1934, 354 p
116 figs. Price 4r. 50k. (bound 5r. 50k.).

The second volume of this work is planned on the same wide a
exhaustive scale as the first. In Chapter V (the numeration
chapters is carried over from vol. 1) the migration of chemi
elements is discussed, including the application of thermodynami
phase rule, and other principles to the various types of concentratio
and dispersions of the elements and the paragenesis of minera
The connexion between the history of atoms and the history of t
earth is traced and the laws of geochemical evolution are outline
In Chapter VI the geochemical processes and systems are describ
and discussed. The magmatic processes are traced through th
successive stages and phases. A number of new definitions (g
chemical systems, provinces, belts, cocentres, &c.) are proposed.
Chapter VII the geochemistry of the hypergenetic (taking place
the surface of the earth) processes is discussed. This includes
review of colloids and biochemistry (biosphere) and a brief accou
of the geochemical factor of mankind (mining and technology). T
tables of data, diagrams, and indexes are as numerous as in the fi
volume. S. I. T

[Fersman (A. E.)] Ферсман (А. Е.). Пегматиты, их научное и пр
тическое значение. Том I, Гранитные пегматиты (второе, доп
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Eigenschaften, Geochemie, Verbreitung, Verwendung. Band
Granitpegmatite (zweite, vermehrte und verbesserte Aufla
Труды Сов. Изуч. Произв. Сил, Акад. Наук СССР (Trans. Cou
Research Econ. Resources, Acad. Sci. USSR), Leningrad, 19
665 pp., 125 figs. Price 25r.

The second edition of this monumental work [M.A. **5**–1] shows
increase of 19 pages and a certain amount of corrections. An
haustive account of the granite-pegmatites is given in the ligh
the geochemical theories of the author. The cooling history of
magma is subdivided into successive stages: magmatic, epimagma
pegmatitic-pneumatolitic, hydrothermal, and hypergenic, and th
in turn are more minutely subdivided into phases indicated
letters and ranging from A (magmatic) to L (hypergenic).
paragenesis of minerals and the various types of pegmatites
discussed, and a long list of references is given. Among new te

oduced is ichthyoglypts for the spindle-shaped quartz crystals n graphic granite [M.A. **2**–63]. S. I. T.

AUXS (R.). *Mineralogie.* Sammlung Göschen. 7th edition. Berlin & Leipzig (Walter de Gruyter & Co.), 1936, 146 pp., 132 figs. Price RM. 1.62.

his is no. 29 in the Göschen collection of over a thousand small × 11 cm.) and thin volumes covering a wide range of subjects. first edition appeared in 1893, when the author was a Privatdo- t in the University of Marburg, and it was used by the abstractor reading-book for the purpose of learning German. The present enth) edition, after a lapse of forty-three years, shows an increase wenty pages, and also the German type is closer set. It gives in r and simple language an elementary account of the forms of erals and their physical and chemical characters. The remaining of the volume gives interesting descriptions of about one hundred non minerals. This little book has had a wide circulation of 00 copies. L. J. S.

LOCK (Herbert P.). *The story of the gems. A popular handbook.* New York (Lee Furman), 1936, [viii] + 206 pp., 34 pls. (2 col.), 28 text-figs. Price $ 3.50.

is attractive volume provides good light reading without being ened with too many scientific details. The text is in part cted from a series of popular articles previously published by author in various magazines [M.A. **3**–437 ; **5**–275, 280]. Chapters The antique use of gems', 'The art of the lapidary', and 'The s in which gems are cut' [M.A. **3**–437 ; with the same set of 28 figures] are followed by chapters dealing with the several kinds nes. Each of the sixteen chapters begins, and often ends, on ht-hand page, and at the beginning of each is a short poetical tion, more or less to the point, set in the middle of a right-hand ; there are thus many blank pages of thick paper. The 32 and white plates, inserted as eight sheets of four pages and the pictures in many cases falling off the edge, give excellent graphic reproductions of the many fine specimens in the Morgan collection in the American Museum of Natural History in New City. The two coloured plates, printed by the three-colour ss, are attractive, but are not really good representations of the ones. The plates are unnumbered and are not referred to in ext. An error, which it seems will never be eradicated from

books on precious stones and mineralogy (even Dana), is the st
ment that Brazilian topaz comes from Ouro Preto and Villa R
(Villa Rica is the old name for Ouro Preto.) How mineralog
(not always the best of geographers) will deal with the frequ
changes of place-names in Russia and central Europe it will
interesting to observe. L. J. S

Brown (J. Coggin). *India's mineral wealth. A guide to the occurre
and economics of the useful minerals of the Indian Empire.* Lon
(Oxford Univ. Press), 1936, x + 335 pp., 6 maps, 8 pls., 21 gra
Price 15*s*.

Although not indicated on the title-page, this is a second edi
of a much smaller paper-covered book with the same title wh
appeared as vol. 4 in the series 'India of to-day', published in 1
(London, Oxford Univ. Press, 121 pp.). It has been considera
enlarged and much improved, and now deals with 110 dist
mineral products, as against 77 in the first edition. Much us
information is presented in a readable form dealing with occurren
both worked and potential, economics, and uses, supplemented
maps of distribution, tables of statistics, and graphs of product
Burma (but not Ceylon) is included. Separate chapters are dev
to fuels, metals and their ores (five chapters), and minerals use
building, ceramics, agriculture, and other industries. Two
chapters deal with gems and semi-precious stones. An appe
gives a selected bibliography to each of the fourteen chapters
statistics of production in 1933 and 1934. The book has been
well printed in India. L. J.

Schultze (Karl). *Das Ausblühen der Salze.* Sonderausgabe aus
Kolloid-Beiheften. Dresden & Leipzig (T. Steinkopff), 1
99 pp., 36 figs. Price RM. 4.

The text of this brochure is built up, almost like beads on a st
from a series of digested extracts from the literature, of whi
bibliography of 163 items is appended. The literature consult
almost exclusively German, although much interesting matter
also have been collected from that in other languages. The eff
cence of salts, as a result of capillary action, is well known fro
creep of solutions on the sides of a containing vessel and the seg
tions on the surface of soils, rocks, and walls. Under different cli
conditions the process is one of geological importance in the n
tion of material and the formation of deposits of nitrates, ba

crite, calcrete, silcrete, ferrocrete (iron-pan), &c. The hardening rock surfaces and the formation of desert polish on stones is cribed to the same action. Many examples of these kinds are llected together, and the subject is discussed from a physical-emical standpoint. L. J. S.

New Minerals.

NNISTER (F. A.), with chemical analyses by M. H. HEY. *Report on some crystalline components of the Weddell Sea deposits.* Discovery Reports, Cambridge, 1936, vol. 13, pp. 60–69, 2 pls.

Calcium oxalate as minute (0·2 mm.) envelope-shaped crystals was nd in samples from depths of 4434–5008 m. These are flat agonal pyramids r (101), $cr = 30° 35'$. X-ray photographs gave l dimensions a 12·40, c 7·37 Å. (c/a 0·594); space-group C^5_{4h}. They identical with larger (3 mm.) crystals on renal calculi, which e on analysis $CaC_2O_4.2H_2O$, not the trihydrate [M.A. **3**–481], with at molecules in the unit cell. Sp. gr. 1·99, corrected for enclosed llite 1·94; H. 4, ω 1·523, ϵ 1·544. Gypsum as small (2 mm.) icular crystals was found in other samples. Calcium citrate, not ore observed in nature, is named *earlandite*. This was found at 22′ S., 16° 34′ W., depth 2580 m., as pale yellow to white, warty ules ½–3 mm. across, which are very minutely crystalline; sp. 1·80–1·95, n 1·56. Micro-chemical analyses give the formula $(Ca_6H_5O_7)_2.4H_2O$. L. J. S.

RNEMAN-STARYNKEVICH (I. D.)] Борнеман-Старынкевич (И. Д.). Химический состав ловчоррита и кондрикита. [*The chemical composition of lovchorrite and kondrikite.*] Хибинские Апатиты, VI, Ленинград (Леноблисполком) [Khibina Apatite, vol. 6, Leningrad (Lenoblispolkom)], 1933, pp. 114–118.

– Работа лаборатории Хибинской горной станции Академии Наук CCCP. [*The work of the laboratory of the Khibina mountain station of the Academy of Sciences, USSR.*] Ibid., pp. 270–275.

esides a description and new analytical data for lovchorrite [M.A. 36, 275], some new mineral species are described. The first two arently represent alteration products of lovchorrite, as they are d encrusting this mineral. *Vudyavrite* (вудъяврит after the lity Vudyavrchorr) is an amorphous glassy mineral of yellowish ur and sp. gr. 2·40–2·50. *Kondrikite* (кондрикит after V. I. drikov), which appears as an opaque yellowish mass, is apparently trolite with microscopic inclusions of an unknown mineral; ysis SiO_2 39·10, TiO_2 4·81, ZrO_2 0·10, ThO_2 0·59, $(Ce,La,Di)_2O_3$

7·24, Al_2O_3 20·65, Fe_2O_3 0·15, (Ca,Sr)O 1·22, Na_2O 10·16, $CO_2 + H_2O$ 14·50 = '98·63'. The suggested formulae are as follows:

Lovchorrite . . . $Ce_4(Ti_2O_6)_3.10Ca_2Si_2O_6.10$–$11NaF$.

Vudyavrite . . . $Ce_4(Ti_2O_6)_3.nSiO_2.mH_2O$.

Kondrikite . . . $mNa_2Al_2Si_3O_{10}.n(Ce_4(Ti_2O_6)_3.10Ca_2Si_2O_6)$.

Some other less definite substances are also described. (1) *Carboce* (карбоцер), a carbonaceous mineral found enclosed in kondrikite with sp. gr. 1·7. When heated it burns, leaving a pink ash. Analysi gave: ignition loss 74·36, SiO_2 5·7, rare-earths 8·2, Al_2O_3 1·5, Fe_2O 0·3, CaO 2·5, Na_2O 1·8, insol. 5·6 (total ash 25·6 %). (2) An amo phous greenish mineral rich in TiO_2 and in rare-earths. (3) A miner similar to rosenbuschite. (4) A black apatite. S. I. T.

[Borneman-Starynkevich (I. D.) = Starynkevich-Borneman (I. D. Старынкевич-Ворнеман (И. Д.). Ловчоррит и его аналог [*Lovchorrite and its analogues.*] Мат. Геохимии Хибинских тунд Акад. Наук СССР [Mat. Geochem. Khibina tundra, Acad. Sc USSR], 1935, pp. 43–65, 3 pls.

—— Методы анализа ловчоррита и его аналогов. [*Methods of analys of lovchorrite and its analogues.*] Ibid., pp. 67–76, 1 pl.

Analyses of lovchorrite (I), rinkolite (II) [cf. M.A. **3**–236], alter lovchorrite (III), vudyavrite (IV and V), and calcium-rinkite (V are tabulated and compared with analyses of rinkite, mosandrit

	I.	II.	III.	IV.	V.	VI.
SiO_2	29·78	29·44	23·43	18·97	23·89	29·78
TiO_2 ...	11·90	11·00	16·51	15·36	18·50	12·49
ZrO_2 ...	0·14	0·16	0·05	0·15	0·05	0·35
ThO_2 ...	0·72	0·46	0·90	1·14	1·17	—
Ce_2O_3 ...	6·83	7·02	9·79	10·28	15·02	—
$(La,Di)_2O_3$ ...	7·26	7·69	12·08	11·78	5·33	—
Y_2O_3 ...	2·73	1·80	1·87	4·00	2·71	—
Al_2O_3 ...	0·25	1·52	0·41	0·23	0·39	2·16
Fe_2O_3 ...	0·05	0·06	0·14	0·14	1·88	0·40
MnO ...	0·11	0·12	0·16	0·23	0·61	2·10
MgO ...	0·15	—	0·19	0·19	0·12	trace
CaO	27·92	26·38	5·12	4·88	2·68	38·32
SrO	1·12	1·62	1·22	0·95	0·10	1·28
Na_2O ...	6·35	6·52	1·35	0·86	0·78	6·44
K_2O ...	0·21	0·42	0·24	0·12	0·09	0·48
F	4·75	5·98	0·19	0·17	—	7·23
H_2O	1·23	1·78	26·10	26·92	26·40	1·16
Total ...	101·58	101·97	99·75	99·67	99·74	102·19
Sp. gr. ...	3·35	—	2·43	2·50	—	3·11

I, also U_3O_8 0·10. V, Ce_2O_3 as CeO_2 15·02.

hnstrupite, rosenbuschite, and pectolite. These minerals form an omorphous series related to pectolite in the pyroxene group, the d-members having the compositions $Ce_2(TiO_3)_3.10CaSiO_3.2CeF_3$ and $a_3(TiO_3)_3.10CaSiO_3.3CaF_2$. The latter, with all Ce replaced by Ca, called *calcium-rinkite*. The original rinkite is an intermediate ember $Ce_2(TiO_3)_3.10CaSiO_3.3CaF_2$. Lovchorrite by metamictic teration passes finally to *vudyavrite* $Ce_2(TiO_3)_3.5(Ca,H)SiO_3.aq.$ *ondrikovite* [= kondrikite in the preceding abstract] is natrolite th microscopic inclusions of a rinkite-like mineral. The second per gives details of the method of analysis of fluo-titano-silicates ntaining rare-earths. S. I. T.

IRVINSKY (P. N.)] Чирвинский (П. Н.). Микроскопическая характеристика ловчоррита и одного его нового аналога из Хибинских тундр.—ČIRVINSKIJ (P.). *Mikroskopische Charakteristik des Lovčorrits und eines neuen Gliedes derselben Reihe aus den Chibina-Tundren.* Мат. Геохимии Хибинских тундр, Акад. Наук СССР [Mat. Geochem. Khibina tundra, Acad. Sci. USSR], 1935, pp. 77–87 (Russian), pp. 87–89 (German summary), 8 pls.

rystalline lovchorrite [M.A. **3**–275] consists of a fluidal aggregate laths usually with straight extinction, negative elongation, and al structure; *n* near 1·657, 2V large. Its inclusion in the pecto- group is doubtful. *Calcium-rinkite* consists of a fluidal aggregate needles and fibres which are sometimes twisted. Positive elonga- n, optic axial plane perpendicular to elongation, *n* 1·635–1·651, *a* 0·012, 2V small. It is probably identical with hainite (J. Blum- , 1893). Mention is also made of a new mineral called *copper- chorrite* or *copper-vudyavrite*. This is emerald-green and amorphous, -59, and is found in kondrikovite veins with amorphous lovchor- . S. I. T.

LEENHEER (L.). *Nieuwe kobalt-mineralen.* Natuurwetenschappelijk Tijdschrift, Gent, 1936, vol. 18, pp. 77–78. (Flemish.)

hree new minerals from Katanga are briefly described. (1) 'Black ' from Ruashi, as a loose soft powder, black and opaque, filling es in malachite; $(Mn,Co)_2O_3.CuO.3H_2O$, with Mn : Co = 2 : 3. Boodtite from Star of Congo mine, friable, grey-black, with allic aspect and bronze tarnish, brown powder, H. 3, sp. gr. 3·1– ; polished sections show some resemblance to stainierite [M.A. **4**– , 347]; composition $5Co_2O_3.CuO.Fe_2O_3.11H_2O$ or

$$2[Co_2O_3(CuO.Fe_2O_3)].3H_2O;$$

named after A. B. de Boodt (1550-1634), author of a treatise o gemstones. (3) A mineral from Kambove, with shining surface an scaly structure, soft and bl... and colloidal;

$$3(Mn_2O_3,MnO_2).Co_2O_3.3CuO.8H_2O.$$

These three hydroxides of cobalt are secondary minerals evident derived from sphaerocobaltite [M.A. **1**–416; **3**–553] which at Mindi occurs in a carbonate rock (57 % carbonates) with malachite, quart haematite, mindigite [M.A. **6**–52], &c. L. J. S.

Dunicz (Bolesław Ludwik). *O tioelaterycie z Boliwji.—Sur la tioél terite de Bolivie.* Arch. Min. Tow. Nauk. Warszaw. (Arch. Mi Soc. Sci. Varsovie), 1936, vol. 12, pp. 90–94 (Polish), p. 9 (French résumé).

A brown elastic bitumen (sp. gr. 0·989) occurs in a silver-tin ve in the Gallofa mine at Colquechaca, Bolivia. Analysis gave C 82·2 H 12·35, N + O 1·69, S 2·96, ash 0·73 %. The sulphur is present thioalcohols and thioethers. The material is a natural vulcaniz elaterite and is named thioelaterite. The Devonian slates and san stones into which the dacite carrying the mineral veins is inject sometimes contain asphalt and petroleum. L. J. S.

Sujkowski (Zbigniew). *Łupki zawierające nikiel w Karpatach.—T nickel bearing shales in Carpathian Flysch.* Arch. Min. To Nauk. Warszaw. (Arch. Min. Soc. Sci. Varsovie), 1936, vol. 1 pp. 118–137 (Polish), pp. 138–143 (English summary), 2 figs

Green, black, grey, and red shales containing nickel (up to 4·48 NiO, with As_2O_5 0·12, Sb_2O_4 1·92, &c.) occur at a definite horizon Lower Cretaceous beds along the Czeremosz river. They cont small nodules of pyrite, millerite, arsenopyrite, and cayeuxite, a larger nodules of carbonates and manganese oxide. The hard (H. dark grey *cayeuxite* nodules, sp. gr. 3·15–3·20, contain SiO_2 15·. S 10·17, As 13·42, Sb 21·61, Fe 16·76, Ge 7·16, Al_2O_3 1·22, Cr 5·85, MoO 1·20, NiO 0·87, CoO trace, ZnO 0·40, MnO 0·08, MgO 1· CaO trace, P_2O_5 0·12, CO_2 1·60, loss at 110° C. 2·76 [a strange resu and different figures are given in the summary !]. L. J. S

Ahlfeld (F.) & Mosebach (R.). *Brickerit, ein neues Mineral.* Zer Min., Abt. A, 1936, pp. 226–231, 287.

Brickerite [M.A. **5**–200] occurs with mimetite in the Lilli mine Lomitos, prov. Sica Sica, dep. La Paz, Bolivia. The white fibr mineral fills veins, or, mixed with calcite and chalcedony, forms la

dules. The needles have a distinct cleavage parallel to their gth, and are probably triclinic; α 1·752, β 1·7555, ν 1·779, 2V 41°, itive, sp. gr. 4·13, H. 4. Analysis by J. Barrande-Hesse gave $_2O_5$ 40·84, ZnO 29·07, CaO 14·84, Fe_2O_3 0·66, SiO_2 1·65, $CaCO_3$ 46 = 97·52; deducting impurities, this gives $4ZnO.3CaO.2As_2O_5$. e later note states that a new analysis and the optical data agree h those of austinite [M.A. **6**–53]. L. J. S.

ULIKOWSKI (Kazimierz). *Skolite, un nouveau minéral du groupe de glauconie.—O skolicie, nowym minerale z grupy glaukonitu.* Arch. Min. Tow. Nauk. Warszaw. (Arch. Min. Soc. Sci. Varsovie), 1936, vol. 12, pp. 145–178 (French), pp. 179–180 (Polish), 1 pl., 4 text-figs.

This mineral fills veinlets and forms part of the cementing material a sandstone (Flysch), containing also some grains of glauconite, Skole, eastern Carpathians, Poland. It is dark green and finely with (001) cleavage. $Bx_a = \alpha \perp (001)$, 2V 0–85° with strong ersion $v > r$, α 1·559, β 1·581, γ 1·586; sp. gr. 2·508–2·572, H. 2. lysis gave SiO_2 49·09, TiO_2 0·21, Al_2O_3 18·17, Fe_2O_3 6·42, FeO 3, MnO trace, MgO 3·10, CaO 1·03, Na_2O 0·23, K_2O 5·62, H_2O 7, P_2O_5 trace = 99·90, corresponding with

$$H_4K(Mg,Fe'',Ca)(Al,Fe''')_3Si_6O_{20}.4H_2O.$$

$4H_2O$ is lost gradually between 20° and 180° and is reabsorbed; the remaining $2H_2O$ commences to escape at 420°. The mineral ttacked by acids leaving a skeleton of hydrated silica which is cally negative and biaxial. The plotted analyses of glauconites a gradation from normal (ferruginous) glauconite to aluminous conites; the latter are classed as pholidoides and include bravai- and skolite. L. J. S.

ÁČEK (Radim). *Revise druhotných uranových nerostů z Jáchymova.* [Revision of the secondary uranium minerals from Jáchymov.] Časopis Národního Musea, Praha, 1935, vol. 109, pp. 100–107.

nce the previous paper [M.A. **6**–148] the cuprosklodowskite from anga, Belgian Congo, has been examined, proving the mineral hymovite') from Jáchymov, Bohemia, to be identical with this. ysis made on 2 mg. of the former gave SiO_2 14·4, UO_3 64·7, 9·0, Fe_2O_3 trace, H_2O 12·1 = 100·2, and there are only slight rences in the optical characters. A comparison of the secondary ium minerals from the two localities shows that sulphates and onates predominate at Jáchymov. L. J. S.

Lapparent (Jacques de). *Formule et schéma structural de l'attapulg*
Compt. Rend. Acad. Sci. Paris, 1936, vol. 202, pp. 1728–17
1 fig. [Cf. M.A. **6**–150.]

From a consideration of the dehydration curve and results of X-
examination it is considered that attapulgite is best represented
the formula $(OH)_2.H_2(Mg_2,Al_{4/3}).Si_3H_4O_{10}$, wherein $3H_2O$ is zeoli
A suggested structure is figured. C. A. S

Lapparent (Jacques de). *Parenté des corps de la série sépiolite-a*
pulgite avec les silicates phylliteux du type mica. Compt. Re
Acad. Sci. Paris, 1936, vol. 203, pp. 482–484.

Further arguments based on a re-examination of the cleavages
comparative chemical compositions are adduced in favour of
author's view that the fibrous structure of sepiolite and attapul
is to be explained by a constitution analogous rather to that of
micas than to that of the amphiboles (asbestos), as advocated
Longchambon and Migeon (loc. cit., p. 431). C. A. S

Artificial Minerals.

Basset (James). *Recherches sur la cristallisation du carbone sous*
hautes pressions. Journ. Physique et Radium, 1934, ser.
vol. 5, pp. 471–474, 3 figs. [Cf. M.A. **6**–7.]

Numerous experiments in which carbon was liberated from orga
and inorganic compounds under high pressure at various temperatu
over a very wide range led only to the production of graphite. Diam
was not obtained. M. H. H

Ridgway (Raymond R.). *Boron carbide. A new crystalline abra*
and wear-resisting product. Trans. Electrochem. Soc. New Y
1935, vol. 66 (for 1934), pp. 117–133, 10 figs.

B_4C is produced commercially by fusing H_3BO_3 with coke at 25
2600° C. The rhombohedral crystals have sp. gr. 2·508–2·522 and
harder than silicon carbide (carborundum). L. J. S

Schwartz (G. M.). *Relations of chalcocite-stromeyerite-argentite.* E
Geol., 1935, vol. 30, pp. 128–146, 8 figs.

Stromeyerite ($Ag_2S.Cu_2S$) was prepared by heating compre
tablets of powdered Ag_2S and Cu_2S at 75° C., and slowly at
ordinary temperature under a pressure of 16,000 lb. per square i
[M.A. **5**–251]. The material is highly anisotropic, and at 93° (

erts into another form (cubic?) showing a bladed structure. As wn by heating and cooling curves and X-ray examination of the ducts, the system Ag_2S–Cu_2S includes no definite compound cor- ponding to jalpaite ($3Ag_2S.Cu_2S$). About 20 % Cu_2S is soluble in S, and about 15 % Ag_2S soluble in Cu_2S, and there may also be a t solubility of Ag_2S and Cu_2S in stromeyerite. L. J. S.

ELIER (V.) & DE SWEEMER (A.). *L'analyse et la synthèse chimiques de la julienite.* Ann. Service des Mines, Comité Spécial du Katanga, 1933, vol. 3 (for 1932), pp. 67–71, 1 fig. [Cf. M.A. **5**–295.]

he system $NaSCN$–$Co(SCN)_2$–H_2O has at 25° C. three solid phases aSCN.$2H_2O$, $Co(SCN)_2.3H_2O$, and $Na_2Co(SCN)_4.3H_2O$. The last ne least soluble and has a limited range of stability. Crystals ined by evaporating a solution containing 2 mols. NaSCN and ol. $Co(SCN)_2$ are identical with julienite. L. J. S.

UTT (St. J.). *O koloidalnym roztworze chalcedonu.—Sur la solubilité de la calcédoine dans l'eau surchauffée.* Arch. Min. Tow. Nauk. Warszaw. (Arch. Min. Soc. Sci. Varsovie), 1936, vol. 12, pp. 64–66 (Polish), pp. 67–68 (French résumé).

owdered chalcedony heated with water in a closed tube at 180– gave a milky solution containing 0·126 g. SiO_2 per 100 c.c., h is coagulated by HCl, $ZnCl_2$, or AmCl. The precipitate gives me X-ray pattern as natural chalcedony. Quartz is less soluble r the same conditions. L. J. S.

UNOV (Alexander) & PETÁK (V.). *O soudržnosti soustavy zrna SiO_2 + koloidy kyseliny křemičité a hydrátu železa, sušené při 110° C.* [On the cohesion of the system SiO_2 in grains + colloidal silica and iron hydroxide, desiccated at 110° C.] Chemické Listy, Praha, 1934, vol. 28, pp. 191–194, 6 figs.

e agglutinizing effect of iron hydroxide in the presence of arti- colloidal silica has its maximum at 4 % Fe_2O_3. Above this ntage the cement becomes porous. F. S.

HEN (C. Stansfield). *A method for the experimental investigation of hydrothermal solutions, with notes on its application to the solubility of silica.* Bull. Inst. Min. Met. London, 1934, no. 364, 26 pp., 1 pl., 8 text-figs.

apparatus is described permitting the withdrawal of filtered les of a solution from an autoclave, thus enabling solubility

determinations to be made at high temperatures and pressures. T apparatus was employed to determine the solubility of silica water; this increases from 0·05 % at 130° C. to 0·2 % at 335° C. I greatly increased by small additions of alkali, but this influe decreases rapidly with rise of temperature. M. H. H.

Greig (J. W.), Posnjak (E.), Merwin (H. E.), & Sosman (R. F *Equilibrium relationships of Fe_3O_4, Fe_2O_3, and oxygen.* Am Journ. Sci., 1935, ser. 5, vol. 30, pp. 239–316, 12 figs.

At 1075° C. magnetite with 8 % Fe_2O_3 in solid solution is in eq librium with haematite containing less than 0·5 % Fe_3O_4. At 1452° the magnetite contains 30 % Fe_2O_3 and the haematite less th 1 % Fe_3O_4, with oxygen at 1 atmos. On cooling, the haematite separa out along the octahedral planes of the magnetite. Pure magnet melts at 1591° C. L. J. S.

Draper (R. B.). *The synthesis of magnesioferrite and some observati on "mineralization"*. Amer. Journ. Sci., 1935, ser. 5, vol. pp. 106–115, 3 figs.

Hydrochloric acid gas was passed over powdered Fe_2O_3 and M in a long porcelain tube along which the temperature was grad At 800–950° C. $FeCl_3$ vapour reacts with MgO with the formatio sharp octahedral crystals (up to 1 mm. across) of magnesiofer ($MgO.Fe_2O_3$). Farther along the tube, at about 700°, haematit deposited as thick crystals with the rhombohedron and hexago pyramid, grading at 500° into thin scales. Excess of MgO yiel minutely crystalline aggregate of periclase. In these experim HCl is acting as a mineralizer. Anhydrous $FeCl_3$ vapour in absence of water and air reacts with MgO with production magnesioferrite and $MgCl_2$ as low as 500° C. L. J. S.

Büssem (Wilhelm) & Köberich (Fritz). *Die Entwässerung des Bru* Zeits. Physikal. Chem., Abt. B, 1932, vol. 17, pp. 310–3 4 figs.

The 'metabrucite' produced by dehydration of brucite consist an aggregate of deformed periclase crystals in parallel position. individual periclase crystals are very thin plates parallel to (1 and have a [111] axis coincident with the *c*-axis of the orig brucite; they are deformed by an extension in the (111) pl [Cf. G. Sachs, M.A. **6**–67.] M. H. H.

SARSSON (Gunnar). *Untersuchungen über Calciumaluminate. IV. Über die Eigenschaften des aus Calciumaluminatlösungen kristallisierenden Aluminiumhydroxyds.* Zeits. Anorg. Chem., 1935, vol. 222, pp. 321–336, 2 figs.

When alumina and lime are fused together in the molecular ratios 1 to 1 : 2 and the powdered mass leached with water immediately, ghly unstable solutions are obtained which deposit, at temperatures m 5° to 90° C., isotropic granules, the composition of which is near $_2O_3.4H_2O$ from solutions at 5° to 50°C., with n 1·52–1·54; at higher nperatures of deposition the water content diminishes towards $_2O_3.3H_2O$, and n increases to 1·58–1·59. At 5° C. these solutions o deposit $CaO.Al_2O_3.10H_2O$ as isotropic granules, n 1·48. If the el and powdered mass is allowed to stand some time before ching, less unstable solutions are obtained, which at low tempera-es deposit isotropic granules similar to the above, but at 20° to C. these are accompanied by spherulites composed of needles, bably $Al_2O_3.3H_2O$, with positive elongation, weak birefringence 003), and n 1·585; at higher temperatures spherulites of tabular als of gibbsite are formed (n 1·58–1·59, high birefringence, icultly soluble in dilute HCl). The isotropic granules all give X-ray der photographs identical with those of gibbsite, but it is suggested they may contain a tetrahydrate, which may be amorphous, or have a gibbsite structure with a part of the Al-atoms missing. needle spherulites give a powder photograph distinct from that gibbsite or of bayerite. New analyses confirm the composition of $O.Al_2O_3.9H_2O$, and show that the compound formerly described $CaO.Al_2O_3.13{\cdot}5H_2O$ [hydrocalumite] has $14H_2O$. M. H. H.

ARSSON (Gunnar). *Die Entstehungsbedingungen der hydratischen Verbindungen im System CaO–Al_2O_3–H_2O (flüssig) und die Hydratisierung der Anhydrokalziumaluminate.* Årsbok Sveriges Geol. Undersök., 1936, vol. 30, no. 6 (Avhandl. och Uppsat., ser. C, no. 399), 202 pp., 26 figs. Price 4 kr.

collection with fuller details of previous papers [M.A. **5**–450] completion of the work on calcium aluminates, which are of portance as constituents of hydraulic cement. The conditions of centration and temperature for the deposition of a number of com-nds from aqueous solutions of calcium aluminate were determined. se include $Ca(OH)_2$ [portlandite]; $5CaO.Al_2O_3.34H_2O$, hexagonal dles; α- and β-$4CaO.Al_2O_3.14H_2O$ and another form with $12(?)H_2O$,

as six-sided plates, but none of them definitely identified with hydr calumite [Min. Mag. **23**–607]; $3CaO.Al_2O_3.6H_2O$, cubic; $3CaO.Al_2O$ $12(?)H_2O$, six-sided plates; $2CaO.Al_2O_3.9H_2O$; $CaO.Al_2O_3.10H_2O$ and five forms of aluminium hydroxide. Optical and X-ray data a given. The stability of these compounds and the constitution of t solutions were determined. The hydration of the anhydrous calciu aluminates $3CaO.Al_2O_3$; $5CaO.3Al_2O_3$; $CaO.Al_2O_3$; and $3CaO.5Al_2$ was also studied. L. J. S.

Weiser (Harry B.) & Milligan (W. O.). *X-ray studies on the hydro oxides. VI.* Journ. Physical Chem., 1934, vol. 38, pp. 117 1182, 4 figs.

The existence of the metastable hydrate bayerite, α-$Al_2O_3.3H$ is recognized; on ageing it gives gibbsite. Gibbsite on isobaric d hydration shows no sign of any intermediate hydrate, although X-r data show that boehmite (γ-$Al_2O_3.H_2O$) is formed; this is due the highly adsorptive character of the γ-alumina formed by dehyd tion of boehmite, which produced a dehydration curve of zeoli type. But the assumed γ-alumina could not be detected by X-r study and is supposed to be very fine grained or even amorphous. M. H. H

Lehl (H.). *Böhmite and bayerite.* Journ. Physical Chem., 19 vol. 40, pp. 47–54.

Four crystalline forms of aluminium hydroxide are knov Diaspore (OAlOH) gives α-Al_2O_3 (corundum) on loss of water. T others, boehmite (OAlOH), bayerite ($Al(OH)_3$), and gibbsite (Al(OH in the increasing order of their stability, all give rise to γ-Al (cubic). L. J. S

Hartman (R. J.), Kanning (E. W.), & Klee (F. Gretchen). *Liesegang phenomenon applied to banded malachite.* Journ. Ch Education (Amer. Chem. Soc.), 1934, vol. 11, pp. 346–3 2 figs.

A banded precipitate closely resembling natural banded malacl is produced when copper salts (nitrate, sulphate, chloride) are allov to diffuse into a silica gel prepared by mixing sodium silicate ammonium carbonate solution, or by passing carbon dioxide i sodium silicate solution. M. H. H

RSE (H. W.) [1873-1936] & DONNAY (J. D. H.). *Optics and structure of three-dimensional spherulites.* Amer. Min., 1936, vol. 21, pp. 391–426, 15 figs.

continuation of previous work [M.A. **5**–104, 119, 258]. Sheaves spherulites of $CaCO_3$, $SrCO_3$, $BaCO_3$, and Ca oxalate were grown elatine containing a dilute solution of one salt into which a con-trated solution of another salt was allowed to diffuse. The forms optics of these are described and discussed in detail. L. J. S.

PARI (W. A.). *Calcium sulphate hemihydrate and the anhydrites. I–Crystallography.* Proc. Roy. Soc. London, Ser. A, 1936, vol. 155, pp. 41–48, 1 pl., 1 text-fig.

rystals of $CaSO_4.\frac{1}{2}H_2O$ were prepared from a solution of $CaSO_4$. O in HNO_3 at 80–90° C. They have the form of hexagonal prisms 0) with rhombohedron $(10\bar{1}2)$ and rarely (0001) and $(10\bar{1}1)$. y patterns show them to be trigonal [not monoclinic, M.A. **5**– with a 6·82, c 6·24 Å., containing three molecules of $CaSO_4$ in unit cell; calculated d 2·60. They contain 5·5–6·5% H_2O, which arly all lost at 130° C., the larger crystals then becoming white opaque and corresponding with 'soluble anhydrite' (calc. d 2·70). uble anhydrite' prepared by different methods always shows the e X-ray patterns as the hemihydrate; and water is taken up by om a moist atmosphere yielding the hemihydrate. The water is rbed in channels in the crystal-structure. L. J. S.

DLA (Pentti), VUORISTO (Urho), & RANKAMA (Kalervo). *An experimental illustration of the spilite reaction.* Compt. Rend. Soc. Géol. Finlande, 1935, no. 9, 8 pp.

rtificial anorthite or natural basic plagioclase was heated in a bomb with water, Na_2CO_3, $NaHCO_3$, and silica (quartz, or derived olivine or Ca_2SiO_4 by the action of H_2CO_3). The felspar was by albitized. Pure albite was obtained at 264–331° C. and clase to andesine at 360–550°. Calcite and dolomite were also ed; but in the presence of $NaHCO_3$ no zeolites. L. J. S.

Karl Heinz). *Über eine neue Synthese von Langbeinit, Vanthoffit und Polyhalit.* Kali, Halle (Saale), 1935, vol. 29, pp. 83–86, 93–96, 103–105, 4 figs.

hydrous sulphates finely powdered and intimately intermixed olecular proportions when heated at about 80° yield langbeinite $O_4.2MgSO_4$) and vanthoffite ($3Na_2SO_4.MgSO_4$). If the material

is previously compressed the reaction in the solid takes place a lower temperature. Anhydrous K_2SO_4 and $MgSO_4$ with gypsum y polyhalite ($K_2SO_4.MgSO_4.2CaSO_4.2H_2O$). The formation of glaube ($CaSO_4.Na_2SO_4$) and glaserite = aphthitalite ($3K_2SO_4.Na_2SO_4$) by method could not be detected by optical and X-ray examinatio the products. L. J. S

Scheumann (K. H.) & Lüdke (W.). *Über Hornblendesynthesen niederen Drucken.* Ber. Math.-Phys. Kl. Sächs. Akad. W Leipzig, 1933, vol. 85, 273–278, 3 figs.

Hornblende fibres were produced on the lines previously indica [M.A. **5**–454] at atmospheric pressure. They show the same X- pattern as natural tremolite. L. J. S

Bowen (N. L.) & Schairer (J. F.). *The system MgO-FeO-S* Amer. Journ. Sci., 1935, ser. 5, vol. 29, pp. 151–217, 28 [Cf. M.A. **5**–252, 454; **6**–261.]

Three series of solid solutions are MgO–FeO (' magnesio-wüstite the olivine series Mg_2SiO_4–Fe_2SiO_4, and the **py**roxene series MgSi $FeSiO_3$. The first two are complete, while the third extends onl 90 mol. % FeO, since $FeSiO_3$ does not exist. The melting-point Mg_2SiO_4 and Fe_2SiO_4 are 1890° and 1205° C., respectively. In pyroxene series the orthorhombic form is stable at lower and monoclinic at higher temperatures, the inversion taking plac 1140° for the magnesium end-member, and 955° C. for the iron- member. A further complication is caused by the incongr melting of the magnesium member with separation of olivine of the iron member with separation of tridymite. The results discussed in connexion with the crystallization of natural mag and their application to slags and refractory materials. L. J.

Bowen (N. L.) & Schairer (J. F.). *Grünerite from Rockport, Ma chusetts, and a series of synthetic fluor-amphiboles.* Amer. M 1935, vol. 20, pp. 543–551, 1 fig.

Grey, finely fibrous grunerite, occurring as a shell around ma of fayalite, gave SiO_2 47·54, Al_2O_3 0·20, Fe_2O_3 0·71, FeO 47·25, 2·14, MgO 0·04, CaO nil, Na_2O 0·29, K_2O 0·11, H_2O 1·55, F 0·0 99·84, formula $H_2Fe_7(SiO_3)_8 = (OH)_2Fe_7(Si_4O_{11})_2$. Sp. gr. 3· α 1·686, β 1·709, γ 1·729, 2V 86°, negative, $c : \gamma = 10°$; polysyntl twinning on (100). This is the iron end-member of the cumm tonite-grunerite series, data for which are plotted to 60 mol. %

$H)_2Mg_7(Si_4O_{11})_2$ [M.A. **4**–528]. Members of a corresponding series fluor-amphiboles were prepared artificially by heating pure clino-statite, pyroxenes of intermediate composition, and $FeSiO_3$ glass the presence of fluorine and absence of oxygen and water. The d-member $F_2Mg_7(Si_4O_{11})_2$ has α 1·583, β 1·590, γ 1·598, $c:\gamma = 8°$, d the end-member $F_2Fe_7(Si_4O_{11})_2$ has α 1·665, β 1·676, γ 1·690, $\gamma = 12°$, The extinction-angle $c:\gamma$ rises to a maximum of 23° r an intermediate member. L. J. S.

RUNER (John W.). *Hydrothermal alteration of montmorillonite to feldspar at temperatures from 245° C. to 300° C.* Amer. Min., 1936, vol. 21, pp. 511–515.

Montmorillonite (bentonite) heated in an aqueous solution of HCO_3 in a bomb for several days or weeks yielded orthoclase. ie fine-grained product was identified by the X-ray pattern; uscovite was not detected. L. J. S.

LL (W.). *Synthese des Montmorillonites.* Die Naturwissenschaften, 1935, vol. 23, p. 197.

— *Synthese von Montmorilloniten. Ein Beitray zur Kenntnis der Bildungsbedingungen und des Chemismus von Montmorillonit.* Chemie der Erde, 1936, vol. 10, pp. 129–154, 1 fig.

Precipitated $Al(OH)_3$ and silica gel in the ratio 1 : 4 were heated water with some alkali at 300° C. (87 atmos. pressure) for about hours, and the products determined by their X-ray patterns. th little alkali both montmorillonite and kaolin are formed, and h still less or none (or in a slightly acid solution) only kaolin. th an excess of NaOH analcime is formed. Similar results were ained in the presence of $Ca(OH)_2$ and $Mg(OH)_2$. With excess of $(OH)_2$ this enters into the composition of the montmorillonite up to 3 % MgO, which then corresponds to fuller's earth. In the natural mation of clay minerals by the hydrothermal alteration of rocks, lkalis accumulate, owing to feeble circulation, then montmorillo-e is formed; whilst if they are removed by an excess of water n kaolin is formed. L. J. S.

RET (*Mlle* Jeanne). *Synthèse sous pression de silicates monocalciques hydratés.* Compt. Rend. Acad. Sci. Paris, 1936, vol. 203, pp. 80–83.

Pure CaO and powdered quartz in the ratio 1 : 1 were heated with) in nitrogen under pressures up to 100 kg. at temperatures of °–200°. The reaction was little affected by change in pressure,

but its rapidity was greatly increased by increased temperatu
In all cases the product is $CaSiO_3.H_2O$, but X-ray examination sho
different forms according as the temperature has been below
above 140°; the low temperature form is identical with that form
at the ordinary temperature by mixing solutions of SiO_2 and Ca
The degree of hydration depends to some extent on the temperatu
of formation, but does not affect the structure, which is also unchang
by partial dehydration at ordinary pressure. C. A. S.

Voos (Ernest). *Untersuchung des Schnittes $CaO.SiO_2$–$MnO.SiO_2$ ternären System SiO_2–CaO–MnO.* Zeits. Anorg. Chem., 19
vol. 222, pp. 201–224, 7 figs.

A synthetic study of the system $CaSiO_3$–$MnSiO_3$, using a vacu
furnace, gave results differing considerably from the schema
diagram of N. Sundius [M.A. **5**-143]. The addition of MnSi
raises the transition point wollastonite ⇌ pseudo-wollastonite v
markedly. No break in the melting-point curve or in the refract
index or density in the wollastonite-bustamite-rhodonite series co
be detected, and Debyeograms showed only gradual changes due
changes in cell sides from 0 to 90 mol. % $MnSiO_3$, but above 9
$MnSiO_3$ a few new lines appeared. There was, however, no evide
of the existence of a gap in composition between bustamite
rhodonite. Nor could any difference be established between natu
rhodonite and bustamite and the synthetic products. Manganifer
pseudo-wollastonites with up to 20 % $MnSiO_3$ were obtained; t
refractive indices and densities and those of the artificial wollaston
bustamite-rhodonite series are given. The curves for the latter se
differ appreciably from Sundius's data on natural material.

M. H. H

Hay (R.), Howat (D. D.), & White (James). *Slag systems.* Jo
West Scot. Iron Steel Inst., 1934, vol. 41, pp. 97–108, 12 fi

White (J.), Howat (D. D.), & Hay (R.). *The binary system M SiO_2.* Journ. Roy. Techn. Coll. Glasgow, 1934, vol. 3, pp. 2
240, 12 figs.

Graham (R.) & Hay (—). *Petrographic methods in slag examina*
Ibid., pp. 241–243.

The three binary systems FeO–MnO, MnO–SiO_2, and FeO–
have been studied from fusions. The refractive indices and c
optical characters of all the products are given. FeO appea
melt incongruently. In the system FeO–MnO, two solid solu

observed; MnO–SiO_2 gives rhodonite and tephroite as sharply racterized compounds, and there is no evidence of any mixed stal formation, except possibly a slight solubility of MnO in ymite; FeO–SiO_2 gives fayalite, and probably grunerite, and no ed crystals. The evidence for the occurrence of grunerite is lly optical; it is only formed above 1600° C. X-ray powder a are given for FeO and MnO. Refractive indices: FeO n 2·00; O n 2·16; tephroite α 1·78, γ 2·00; $MnSiO_3$ n 1·76; tridymite 49; fayalite α 1·78, γ 2·00; grunerite n 1·74. M. H. H.

ER (W.). *Die Mineralien der Bleischlacken. Anwendung gesteinskundlicher Untersuchungsmethoden auf Schlacken.* Chemie der Erde, 1935, vol. 10, pp. 67–115, 2 pls., 15 text-figs.

hemical analyses and optical determinations are given of several tions separated by heavy liquids from a lead slag from the Harz. minerals identified include α-celsian [M.A. **5**–102], willemite, lite, magnetite, zinc-blende, and wurtzite. The diagrams of the ems CaO–FeO–SiO_2 and γ-Ca_2SiO_4–Mg_2SiO_4–Zn_2SiO_4–Fe_2SiO_4 are ussed. L. J. S.

Topographical Mineralogy.

SBURY (Arthur W. G.). *Notes on some recent finds of minerals on the Mendip Hills.* Proc. Somerset. Archaeol. Nat. Hist. Soc., 1935, vol. 80 (for 1934), pp. 51–56.

ditions to the list of minerals found at Higher Pitts, Priddy . Mag. **20**–67], are pyromorphite and rhodochrosite. In andesite Moonshill, Shepton Mallet, chalcosine, chrysocolla, and cuprite e been found in small amount. L. J. S.

NER (Heinz). *Neue Mineralfunde in den österreichischen Ostalpen. VI.* Mitt. Naturwiss. Ver. Steiermark, 1935, vol. 72, pp. 61–66.

rief descriptions are given of the occurrence of arsenolite (white ly crust on native arsenic), an aluminium phosphate gel, and ne from near Schladming, and of various other minerals from lities in Styria (Steiermark). L. J. S.

ERLANDT (H.). *Einige interessante Mineralfunde aus den Hohen Tauern.* Mitt. Wien. Min. Gesell., no. 100, for 1935 *in*: Min. Petr. Mitt. (Tschermak), 1936, vol. 47, pp. 393–397.

ew mineral finds in the Habachthal [M.A. **5**–488] and Rauris the neighbourhood are mentioned, including large (over 1 metre) als of smoky-quartz and a new spot for emerald. L. J. S.

K· ERA (Bruno) [1863–1934]. *Doplňky k seznamu nerostů za l 1929–1933.* [Supplements to the list of minerals for the ye 1929–1933.] Sborník Klubu Přírodovědeckého, Brno, 19 vol. 16 (for 1933), pp. 53–59. [Cf. M.A. **5**–86.]

Many new occurrences are recorded from Moravia and Cz Silesia, particularly from the crystalline schists and plutonic ro of western Moravia. F. S.

KAŠPAR (Jan Václav). *Stručný nástin mineralogie a geochemie klad ského karbonu.* [A short sketch of the mineralogy and g chemistry of the Carboniferous of Kladno.] Věstník Státn Geol. Ústavu Československé Republiky, 1933, vol. 9, pp. 2 303 (Czech with German summary), 6 figs.

In the clay-ironstone septaria and in crevices in various sedim tary rocks in the Kladno coal basin the mineral paragenesis constant and characteristic. The prevailing carbonates are of generations, chalybite and ankerite being earlier, and calcite dolomite later than baryte and the sulphides (galena, blende, lerite, pyrrhotine, pyrite, marcasite, chalcopyrite, and linnaei Whewellite and nacrite are the youngest minerals. The vari habits of baryte crystals do not agree with the views of Kalb Koch [M.A. **5**–38] on the relations between paragenesis and crys habit. The nacrite has crystallized from solution, and is q different from the kaolin formed in arkoses. Biochemical proce have in general played a very important part in the whole pa genesis; e.g. in the accumulation of magnesium in the carbona and in the concentration of the metals forming part of the sulphi F. S.

ULRICH (František). *Nové mineralogické nálezy z Čech I. Barrand* [New mineralogical finds in Bohemia. I. Barrandian.] Časo Národního Musea, Praha, 1935, vol. 109, pp. 79–89.

In the sedimentary and eruptive rocks of the Barrandian (Alg kian to Devonian) of central Bohemia many new occurrences common minerals have been found during recent years. Ordovic slates at Vokovice have in their harder concretions a succession minerals similar to that of the Kladno coal beds; the succes being: quartz, ankerite I, pyrite and chalcopyrite, blende baryte, calcite and ankerite II, and nacrite. Pyritiferous slates many places in the Praha district show crusts of secondary sulphat

ite, natrojarosite, fibroferrite (uniaxial, n 1·566 $\parallel c$, n 1·631 $\perp c$), nite, and gypsum. New localities are given for secondary rals (prehnite, analcime, natrolite) in diabase. F. S.

ETAL (Karel). *Minerogenetické poměry země moravskoslezské* [Minerogenetic features of the Moravian-Silesian country.] Sborník České Vysoké Školy Technické v Brně, 1934, vol. 8, no. 30, 23 pp. with 3 pp. German summary, 2 maps.

d and new mineral occurrences in Moravia and Czech Silesia are acterized and classified from a geological and petrogenetic point ew. New data regarding the parent-rocks are given from the or's field investigations and study of the rich regional collections e County Museum at Brno. F. S.

EK (Josef). *Vivianit z lesnich půd adamovských.* [Vivianite from he forest soils of Adamov, Moravia.] Příroda, Mor. Ostrava, 1935, vol. 28, pp. 279–281.

alysis of blue spherulitic concretions gave P_2O_5 27·25, Al_2O_3 0·31, 4·27, FeO 37·20, MgO 0·57, CaO 0·85, H_2O+ 13·18, H_2O- 14·37, 1·42 = 99·42. F. S.

EC (František). *Nové nálezy nerostné od D. a H. Borů u Vel. Meziříčí (záp. Morava).* [Newly found minerals from Dolní and Horní Bory near Velké Meziříčí, (western Moravia.)] Věda Přírodní, Praha, 1935, vol. 16, pp. 287–289.

mortierite as prismatic crystals in pegmatite; α 1·668, γ 1·689; hroism, $\alpha = c$ reddish-violet to crimson, γ colourless. Chlor- te in andalusite aggregates in pegmatite; sp.gr. 3·22, n 1.633. F. S.

(Rudolf). *Několik nových minerálů pro ČSR z Kladenska.* Some new minerals for Czechoslovakia from Kladno.] Věda Přírodní, Praha, 1935, vol. 16, pp. 203–204.

preliminary account is given of the following minerals found rning heaps of Carboniferous sediments rich in pyrite. Native um (the rhombohedral γ modification), letovicite, mascagnine, mmoniac, α-sulphur, copiapite, epsomite, hexahydrite, pickerin- apparentite, and organic substances (fluorene and anthracene). F. S.

Vendl (Mária). *Adatok a hazai kalcitok kristálytani ismeretéhe*
Vendl (Maria). *Daten zur kristallographischen Kenntnis ungarischen Kalzite.* Mat. Term.-tud. Értesítő, Budapest, 19 vol. 49, pp. 167–178, 11 figs. (Hung.), pp. 179–180 (Germ.)

Crystallographic descriptions are given of calcite from Kiskő (= Batina), com. Baranya; Bucsony (= Bucsum), com. Alsó-Fel Ruzsinabánya, Budfalva, com. Máramaros; Luhi, com. Máramar Óradna, com. Beszterce-Naszód; Nagyág, com. Hunyad; and Viseg com. Pest. [M.A. **4**–234, 519.] V. Z

Tokody (László). *Lice néhány ásványáról.*—Tokody (L.). *Ü einige Mineralien von Lice.* Mat. Term.-tud. Értesítő, Budap 1934, vol. 51, pp. 495–499 (Hung.), pp. 500–501 (Germ.).

Descriptions are given of halloysite, malachite, chessylite, v and psilomelane from the iron (haematite and limonite) min Lice, com. Gömör. Analysis by G. Vavrinecz of the halloysite g after deducting impurities, SiO_2 34·18, Al_2O_3 37·20, Fe_2O_3 0·08, M 0·09, H_2O 28·45 = 100·00. V. Z

Koch (Sándor). *Ásványtani közlemények Gömörmegyéből.* [Min logical notes from comitat Gömör.] Földtani Közlöny, Bu pest, 1934, vol. 64, pp. 155–160, 1 fig. (Hungarian with Ger summary.)

Visible gold is present in the quartz of the country-rock of auriferous stibnite veins at Csucsom near Rozsnyó. Goethite crys from Lice show the forms *d b*, (*0kl*), (*hkl*). Apatite, as pale vi crystals up to 1 cm. across, is of rare occurrence with albite crystallized chalybite from Sajóháza. It is a fluor-apatite contai a small amount of chlorine. The crystals of flat-bipyramidal h show the forms *c m a r x y s* [Dana's letters]. V. Z

Koch (Sándor) & Zombory (László). *Újabb magyarországi anker magnezit előfordulások.*—Koch (S.) und Zombory (L. v.). *Ne Ankerit- und Magnesit-Vorkommen aus Ungarn.* Földtani löny, Budapest, 1934, vol. 64, pp. 160–162. (Hungarian German summary.)

Transparent ankerite crystals ($-\frac{1}{2}R$) up to 4 cm. across Hollópatak, com. Szepes, gave analysis I, corresponding $8CaCO_3.(4FeCO_3.3MgCO_3.MnCO_3)$. Magnesite crystals up to 5 across, and yielding clear colourless cleavage rhombs, from kószuha, gave II. Magnesite as white to colourless spheroidal ag

es from Ujmoldova, gave III; single crystals bounded by an acute mbohedron and the basal plane are rare.

	CaO.	MgO.	FeO.	MnO.	CO_2.	Insol.	Total.	d_4^{20}.
I.	27·97	9·10	15·75	3·67	43·88	—	100·37	3·077
II.	0·95	44·46	2·87	0·37	51·53	0·07	100·25	3·031
II.	0·18	45·22	2·39	trace	50·52	1·39	99·70	2·998

V. Z.

ÁVA-KOVÁTSNÉ formerly RESCH (Katalin). *Adatok a magyarországi kalkopiritek kristálytani ismeretéhez.*—Frau SZÁVA-KOVÁTS, K. RESCH. *Beiträge zur kristallographischen Kenntnis der ungarischen Kupferkiese.* Földtani Közlöny, Budapest, 1934, vol. 64, pp. 334–341, 9 figs. (Hungarian with German summary.)

rystals of chalcopyrite from Brád, com. Hunyad, mostly of ramidal habit, show the forms $p\,p_1 z\,e\,h\,g\,t\,m\,c$ [Dana's letters], 07), and χ(704), and are twinned on p or with twin-axis $\perp m$; n Bucsony (= Bucsum), com. Alsó-Fehér, with predominating z, $p\,e\,m\,g\,h\,c$; from Sajóháza, com. Gömör, with $z\,e\,p\,s\,m$; and from molnok, com. Szepes, with $e\,p\,y\,s\,c\,g\,q\,m$, χ(704), τ(605), and 05). V. Z.

KODY (László). *Anglezit, cerusszit és wulfenit új magyarországi előfordulásai.*—TOKODY (L.). *Neues Vorkommen des Anglesits, Cerussits, und Wulfenits in Ungarn.* Földtani Közlöny, Budapest, 1934, vol. 64, pp. 341–347, 2 figs. (Hungarian with German summary.)

nglesite on galena from Soborsin, com. Arad, shows the forms c $o\,z\,y$ [Dana's letters] and R (10.9.0), with m predominating. Cerus- as light brown translucent crystals from Almásbánya, com. Arad, gated along the a-axis and twinned on m, show $b\,m\,r\,i\,k\,x\,p$ [Dana's ers]. Wulfenite, a single crystal with cerussite on johnstonite and na, from Új Sinka, com. Fogaras, shows only p(111). V. Z.

CHERT (Róbert). *Néhány újabb adat hazai ásványelőfordulások ismeretéhez.*—REICHERT (R.). *Neuere Daten zur Kenntnis ungarischer Mineral Vorkommen.* Földtani Közlöny, Budapest, 1934, vol. 64, pp. 348–356, 5 figs. (Hungarian with German summary.)

arcasite in coal-shale of Cretaceous age from Csingervölgy, near a, com. Veszprém, is of two types: (1) with $l\,e\,m\,c\,v$ [Dana's letters] (hkl), l and e predominating; (2) with $l\,e\,m$ resembling dodeca-

hedra. Sp. gr. (d_4^{20}) 4·823. Brownish to deep smoky-quartz in pyroxe andesite from Kékes Mt., Mátra Mts., has ω 1·5442, ϵ 1·5537, d_4^{20} 2·6 Pneumatolytic amphibole and biotite occur in cavities in a hype thene-andesite from Nagy-Inóc Mt., Börzsöny Mts.; the bro amphibole of prismatic habit shows the forms *m b a c p l t* [Dan letters] and (021), and has $\gamma : c = 17°$. Phillipsite as pseudo-tetrago twins encrusting cavities in basanite from Medves Mt., com. Nógr Hont, shows *c b m n*; α 1·497, γ 1·504, $\gamma : a = 10°–17°$. V. Z.

Koch (Sándor) & Zombory (László.) *Szferosziderit és sziderit Fel bányáról.*—Koch (A.) und Zombory (L. v.). *Sphärosiderit u Siderit von Felsőbánya.* Földtani Közlöny, Budapest, 19 vol. 65, pp. 18–20, 1 fig. (Hungarian with German summar

Sphaerosiderite recently found at Felsőbánya contains inclusi of baryte, plumosite, and pseudomorphs of cervantite after stibni analysis I. Chalybite as light brown translucent crystals *c e a r* also been recently found here; anal. II.

	CO_2.	FeO.	MnO.	MgO.	CaO.	Total.	d_4^{20}.
I.	38·52	40·10	19·20	0·21	1·49	99·52	3·852
II.	38·35	55·71	3·42	1·71	0·53	99·72	3·879

V. Z

Kertai (György). *Rudabánya oxidációs zónájának új ásványai* Kertai (Gy.). *Neue Vorkommen aus der Oxydationszone Rudabánya.* Földtani Közlöny, Budapest, 1935, vol. 65, pp. 30, 5 figs. (Hungarian with German summary.)

Crystals of malachite occur in cavities in malachite pseudomorph after chessylite; the malachite shows the forms *c m*, and the ches lite *c* ϕ *s* [Dana's letters]. Cerussite occurs with galena, sulphur, earthy cinnabar on limonite; the crystals are elongated along *a*-axis and show the forms *a b x i y m r p*. Baryte crystals on limo show *c m o d*. V. Z

Tokody (László) & Vavrinecz (Gábor). *A vaskői ankerit és cosalit* Tokody (L.) und Vavrinecz (G.). *Ankerit und Cosalit Vaskő.* Földtani Közlöny, Budapest, 1935, vol. 65, pp. 3 305, 1 fig. (Hungarian with German summary.)

Fibrous cosalite from Vaskő, Banat [M.A. **3**–7; **4**–480], associa with chalcopyrite and calcite in ankerite, is easily polished and sh anisotropism and reflection pleochroism (very pale rose and grey black) and responds to etching agents. Analysis gave S 17·

40·21, Sb 0·04, Pb 39·55, Cu 2·71, Fe 0·25, insol. 0·74 = 100·70, rresponding with $Pb_2Bi_2S_5$; d_4^{20} 6·63. Ankerite, as yellowish-brown ystals (10$\bar{1}$1) gave CaO 29·09, MgO 10·30, FeO 15·74, MnO 0·66, sol. 0·40, CO_2 (diff.) 43·81. V. Z.

ERTAI (György). *Hidrotermális aragonit andezitből és mészkőből.*— KERTAI (G.). *Hydrothermale Aragonitvorkommen in Andesit und Kalkstein aus Ungarn.* Földtani Közlöny, Budapest, 1935, vol. 65, pp. 354–362, 3 figs. (German with Hungarian summary.) Aragonite crystals in pyroxene-andesite from Gyöngyösszücsi, tra Mts., com. Heves, are of two types: (1) colourless or yellowish edles, up to 35 mm. long and 3 mm. thick, with the forms *b k m* ana's letters], polysynthetically twinned and encrusted with eite; (2) violet crystals, up to 74 mm. long and 15 mm. thick, th the same forms, and α 1·5308, β 1·6813, γ (calc.) 1·6861. stals on the walls of a small cave in Triassic limestone at Üröm ar Budapest have the form of thin plates (parallel *b*) with *b m k p*, *l*) and (*hkl*), or of very thin needles, and are associated with crypto-stalline aragonite and rhombohedra of calcite. Crystals in Triassic estone from Felső-Galla, com. Komárom, are up to 12 mm. long, the forms *b m k*, (*hkl*), and associated with rhombohedra of cite. V. Z.

BUNTZOV (A. N.)] Лабунцов (А. Н.). Месторождения молибденита в Хибинских тундрах. [*The occurrences of molybdenite in Khibina tundra.*] Мат. Геохимии Хибинских тундр, Акад. Наук СССР [Mat. Geochem. Khibina tundra, Acad. Sci. USSR], 1935, pp. 5–41, 1 pl. (map), 5 text-figs.

Various occurrences of molybdenite are described. It is found in rine-felspar-pegmatite veins, in albite-fluorite veins, in the pyr-tine zone [M.A. **6**–310], and in a zone between ijolite and inite. S. I. T.

LON (J.) & DONNAY (J. D. H.). *Pyrite, sulfates, destinézite et zéolites de l'île de Chypre.* Bull. Soc. Géol. Belgique, 1936, vol. 59, pp. B 162–B 166.

Brief descriptions are given of the following minerals from Skourio-, Cyprus [M.A. **2**–549]. Pyrite, sulphur, gypsum, cyprusite agonal, uniaxial, positive, $n > 1{\cdot}74$), copiapite, römerite, destine-(α and β near 1·618, γ 1·670), voltaite (*d* 2·74, *n* 1·593, 2V 50° itive; the cubic crystals, *o d*, contain Fe_2O_3, Al_2O_3, K_2O, but no

FeO), coquimbite, alunogen, chalcanthite, tamarugite, opal, fibroferri (γ 1·575), halotrichite, analcime, and gmelinite (optically negativ not positive, γ 1·474, 2V 0–90°). L. J. S.

The mineral deposits of Abyssinia. Bull. Imp. Inst. London, 193 vol. 34, pp. 235–238.

Gold, platinum [M.A. **4**–46], mica, potash, and lignite have be worked. Mention is made of coal, oil, sulphur, &c. Turquoise h been worked at Got near Angolola, and diamond reported fro Uddur. A bibliography is added. L. J. S.

Mineral resources of the Somaliland Protectorate. Bull. Imp. In London, 1936, vol. 34, pp. 233–235,

Salt (analyses and statistics given) is obtained by the evaporati of sea-water. Phosphate and mica have been worked on a small sca Oil, coal, silver-lead ore, baryte, beryl, garnet, limestone, and mar are mentioned, and traces of gold and platinum have been detect L. J. S

Ulke (Titus). *Minerals of the District of Columbia and vicinity, u pertinent bibliography.* Rocks and Minerals, Peekskill, N. 1936, vol. 11, pp. 7–9, 26–28, 42–44.

An alphabetical list of 85 species and 40 varieties of minerals, w brief particulars of their occurrence, found within a radius of fi miles around Washington, D.C., in the States of Maryland Virginia. L. J. S

Pough (Frederick H.). *Bertrandite and epistilbite from Bedford, N York.* Amer. Min., 1936, vol. 21, pp. 264–265.

Minute crystals of bertrandite on the slightly etched surface beryl from pegmatite in Baylis quarry are covered with a later cr of epistilbite. L. J. S

Dunham (Kingsley C.). *Crystal cavities in lavas from the Hawa Islands.* Amer. Min., 1935, vol. 20, pp. 880–882.

Corrections and further notes on a previous paper [M.A. **6**–131 L. J. S

Simpson (Edward S.). *Contributions to the mineralogy of Wes Australia. Series IX.* Journ. Roy. Soc. W. Australia, 19 vol. 22 (for 1935–36), pp. 1–18, 1 fig.

(1) Actinolite, Comet Vale, Central Division.—A bluish-g amphibole, resembling glaucophane in appearance, gave analysi

3·04, α 1·629, γ 1·651, $c : \gamma = 15°$. (2) Chlorites.—Corundophilite om Holleton, South-West Division, as slate-green plates, anal. II; 2·80, α 1·582, γ 1·590, 2E 30°, positive. Clinochlore from Nin-anboun Hills, SW. Div., dark greyish-green plates, anal. III; 2·69, 2E small, positive. Daphnite from Randalls, Central Division, mpact greenish-black with mispickel, anal. IV; d 3·14, α 1·656, 1·661, negative. (3) Cobaltite and erythrite, Ravensthorpe, SW. iv.—Cobaltite as small grains and imperfect octahedra in gold uartz gave S 18·99, As 45·73, Co 30·64, Ni 1·03, Fe 3·61. (4) Fuch-te, miloschite, and alexandrolite, Meekatharra, Murchison Division. -Bands of quartz-mesitite-fuchsite-rock, representing carbonated ridotite or pyroxenite are met with in several of the gold mines, e waste-heaps of which are bright green in colour. Nine partial alyses of this material indicate mixtures of fuchsite and secondary romiferous clay minerals. (5) Montebrasite, Ravensthorpe, SW. ., and Ubini, Central Division.—Partial analysis of greyish-white avage material (d 2·95, α 1·599, γ 1·628) from Ravensthorpe indi-tes the presence of $LiAl(OH)PO_4$ 76·7, $LiAlFPO_4$ 19·1 %. Yellowish avage material associated with white amblygonite from Ubini ve analysis suggesting the formula $H_3Li_5Al_8(OH)_9F_2$ or a mixture montebrasite and coeruleolactite (?). (6) Muscovite, Wodgina, W. Div.—A compact pea-green mineral taking a good polish and table for carving gave anal. V; d 2·84, H. 3½. (7) Sillimanite l kyanite.—Sillimanite occurs with andalusite in quartz-mica-ists at several places near Toodyay, and as fine needles with ite in fireclay at Clackline, SW. Div. (8) Stibiotantalite, Green-shes, SW. Div.—This occurs as a replacement of tantalite in a isenized pegmatite. Imperfect crystals are described. A new

	SiO_2.	Al_2O_3.	Fe_2O_3.	FeO.	MnO.	MgO.
I.	56·80	0·62	1·45	6·71	0·23	19·75
II.	28·08	22·16	1·46	9·56	0·04	26·54
III.	32·40	19·17	2·36	4·04	nil	27·62
IV.	23·43	18·21	4·49	36·30	trace	5·41
V.	46·01	37·08	0·18	0·16	0·05	0·16

	CaO.	Na_2O.	K_2O.	H_2O+.	H_2O-.	Total.
I.	11·24	0·71	0·12	2·58	0·15	100·48
II.	nil	nil	0·04	12·66	0·26	100·80
III.	nil	nil	nil	12·21	1·56	99·85
IV.	nil	nil	nil	12·15	trace	99·99
V.	0·22	0·54	10·79	4·58	0·12	99·89

I, also TiO_2 0·12. III, also TiO_2 0·17, NiO 0·32.

ana[illegible]sis gave Ta_2O_5 57·29, Nb_2O_5 1·79, Sb_2O_3 40·64, Bi_2O_3 0·30; *d* 7·345. Pebbles from alluvial deposits gave *d* 6·41–7·48. (9) Zoisite.—Analyses are given of impure material from three localities.

L. J. S.

Hutton (C. O.). *Mineralogical notes from the University of Otago.* Trans. Roy. Soc. New Zealand, 1936, vol. 66, pp. 35–37.

Chlorite from Red Mountain, south Westland.—Hexagonal plates of chlorite with serpentine fill a narrow vein in peridotite. It is uniaxial positive with unusual pleochroism (α and β colourless, γ pale brownish-yellow); α 1·588, γ 1·594. Analysis gave SiO_2 30·90, TiO_2 trace, Al_2O_3 17·18, Fe_2O_3 0·02, FeO 9·06, MnO 0·14, MgO 29·83, H_2O (+105°) 12·60, H_2O (−105°) 0·35 = 100·08, formula

$$5(Mg,Fe,Mn)O.(Al,Fe)_2O_3.3SiO_2.4H_2O.$$

It is a manganiferous clinochlore, and the pleochroism is attributed to the manganese. Strontium-aragonite from Alexandra, central Otago.—Creamy-white, radiating fibrous material, sp. gr. 2·90–2·91, α 1·527, γ 1·676, gave $CaCO_3$ 93·28, $SrCO_3$ 5·51, $BaCO_3$ trace, SiO_2 and insol. 1·42 = 100·21.

L. J. S.

Economic Minerals and Ore-deposits.

[Fersman (A. E.)] Ферсман (А. Е.). К геохимии золота.—Fersman (A.). *Sur la géochimie de l'or.* Докл. Акад. Наук СССР (Compt. Rend. Acad. Sci. URSS), 1931, pp. 199–204 (Russian).

The geochemical diagram of granodioritic magma is presented and the differentiation of the gold-bearing hydrothermal portion is discussed. Gold is associated with the volatile distillates of granodioritic magma which crystallized out at a comparatively late stage (below 400°, with a maximum at about 250°).

S. I. T.

[Zavaritzky (A. N.)] Заварицкий (А. Н.). Коренные месторождения платины на Урале.—Zavaritsky (A.). *Primary platinum deposits of the Urals.* Геол. Ком., Мат. общ. и прикл. геологии (Geol. Comm., Mater. general & appl. geol.), Leningrad, 1928, no. 103, 56 pp., 5 pls., 11 text-figs. (Russian with English summary.)

Primary platinum deposits are associated with segregations of chromite in dunite. These segregations, in the form of irregular nests or schlieren, are irregularly distributed among the bodies of dunite of the central Urals. Dunite is a member of the differentiation complex of basic magma, comprising pyroxenite, gabbro, granodiorite, and a set of later dikes. The theory that dunite was formed

the accumulation of sinking olivine crystals is questioned, and it suggested that it crystallized out from its own magma comparately rich in volatiles. This is supported by the evidence of miarolic cavities in the dunite, in which idiomorphic crystals of olivine found together with uvarovite, chlorite, chrome-idocrase, and rome-diopside. The presence of volatiles is also suggested by the olution of gas from a deep bore-hole in the dunite. The crystallizan of chromite and platinum took place at a late stage of the cooling the dunite magma, but before its final solidification. This was owed by the serpentinization of dunite and the separation of small ounts of native copper. Secondary alteration of platinum (formaon of rims rich in Cu and Fe) is also assigned to this stage. The ch is well illustrated by numerous micro-sections and several lyses are given. [Cf. M.A. **1**–179; **2**–272, 540.] S. I. T.

VAGINTZEV (O. E.) & FILIPPOV (A. N.)] Звягинцев (О. Е.) и Филиппов (А. Н.). О нахождении платины в сернистых рудах.—ZVÏAGINCEV (SWIAGINZEW) (O.) & FILIPPOV (A.). *Über das Vorkommen des Platins in Sulfiderzen.* Докл. Акад. Наук СССР (Compt. Rend. Acad. Sci. URSS), 1935, vol. 1, pp. 130–132 (Russian), pp. 133–135 (German).

—— —— О содержании платины в минералах сернистых руд.—*Über den Platingehalt in Mineralen der Sulfiderze.* Ibid., pp. 136–137 (Russian), pp. 138–139 (German).

ata are given on the content of platinum in sulphide ores and erals of Ural and Caucasus. They are of the order of 10^{-8} to % S. I. T.

KHAROV (E. E.)] Захаров (Е. Е.). Минералогия Садонской рудной жилы.—*Mineralogy of the Sadon ore vein.* Садонское свинцово-цинковое месторождение.—ZAHAROV (E.). *The lead-zink deposit of the Sadon mine (Kaukasus).* Научно-Техн. Упр. В.С.Н.Х. (Sci. Techn. Dep. Supreme Council of National Economy), no. 368, Труд. Инст. Прикл. Мин. (Trans. Inst. Econ. Min.), Moscow, 1930, no. 46, pp. 54–154, 1 pl., 42 text-figs. (Russian with English summary, p. 153.)

he Sadon zinc-lead lode, 2100 m. long and irregular in width c. 19 m.), is associated with a thrust-breccia in the granite and s. The principal minerals, in order of abundance, are: blende, ntiferous galena, pyrrhotine, pyrite, chalcopyrite, arsenopyrite, nolybdenite. The gangue minerals are: quartz, calcite, chlorite,

muscovite, and humite (?). The lower levels of the lode are richer i blende and quartz, while the upper are richer in galena and calcit Ferriferous blende is more abundant in the lower levels. Th paragenesis and metasomatism of minerals is outlined and twenty two analyses are given. S. I. T.

[Miropolsky (L. M.)] Миропольский (Л. М.). Сидероплезит и писто мезит в качестве первичных железных руд на Бакале (Южны Урал.—Miropolskij (L.). *La sidéroplésite et le pistomésite e leur qualité de minerais de fer primaires au Bakal* (*Oural du Sud* Докл. Акад. Наук СССР (Compt. Rend. Acad. Sci. URSS), 193 pp. 104–108.

According to the chemical analyses (20 analyses of iron ores ric in $MgCO_3$ are given), optical properties (ω 1·810–1·838, ϵ 1·581 1·602), and specific gravity (3·72 3·85), the 'siderite' of the Bakal iro ore deposits is assigned to the group of sideroplesite and pistomesit Other minerals recorded are: hydrohaematite (turgite), hydrogoethit (limonite), goethite, iron-glance, magnetite, pyrite, ankerite, ar brown-spar. S. I. T.

[Fersman (A. E.)] Ферсман (А. Е.). Новый промышленный цен СССР за полярным кругом (Хибинский апатит). [*A new i dustrial centre of the USSR beyond the polar circle* (*Khibins apatite*).] Изд. Акад. Наук СССР (Publication of Acad. S USSR), Leningrad, 1931, 55 pp., 3 maps, 12 text-figs.

This is a fascinating account of the progress made in the explorati and exploitation of the Khibina tundra apatite deposits. The buildi of a new railway and of a new town of Khibinogorsk (now renam Kirovsk) are described. The new Mountain Scientific Station of t Academy of Science 'Tietta' is also briefly described. [Cf. M.A. 232.] S. I. T.

Gedeon (Tihamér). *Sztudenei rézércelőfordulás.*—Gedeon (T.). *Ku fererzvorkommen von Studene* (*Südserbien*). Földtani Közlö Budapest, 1935, vol. 65, pp. 50–52, 2 figs. (Hungarian w German summary).

A copper ore near Studene, ESE. of Nis in southern Serbia, co sists of pebbles of chalcosine (Cu 72·32, Ag 0·22, S 17·50 %) formi 10 % of a quartzitic detritus. The available ore is estimated 8,000–10,000 tons. Near Bancarevo, NE. of Studene, Permian sa stone is impregnated with malachite, chessylite, and black oxi

h a thickness of 60–80 cm. and a distance of 100 m. The rock tains 8 % Cu. V. Z.

NHAM (Kingsley Charles). *The genesis of the north Pennine ore deposits.* Quart. Journ. Geol. Soc. London, 1934, vol. 90, pp. 689–720, 2 pls., 3 text-figs.

The zonal distribution is emphasized. In the central area fluorite is sent in the veins, and in the outer area baryte (or locally witherite), h a narrow intermediate zone containing both or neither. [Cf. n. Mag. **22**–259.] Sulphide minerals also show a zonal distribution, from the centre outwards: I, chalcopyrite, with subordinate ena and zinc-blende (Tynehead copper mines); II, galena with erdinate zinc-blende; III, galena and zinc-blende; IV, galena; sulphides absent. The veins have no connexion with the Whin , and they are attributed to a sub-Pennine granitic magma, of ich there is no direct evidence. L. J. S.

EUTZWALD (Anton). *Die Blei-Zinkerzgänge am Schauinsland im südwestlichen Schwarzwald.* Neues Jahrb. Min., Abt. A, 1935, Beil.-Bd. 70, pp. 234–334, 7 pls., 5 text-figs.; Inaug.-Diss. Freiburg i. Br., 1935.

The argentiferous lead-zinc mine on the Schauinsland, 10 km. south Freiburg, Baden, has been worked for over a thousand years. The re are in intrusion gneiss and aplite, and they have brecciated lders carrying ore. Detailed descriptions are given of the several ns and their mineral paragenesis. L. J. S.

MER (Ernst). *Beiträge zur Kenntnis der Edlen Quarzformation Freibergs unter besonderer Berücksichtigung der Silberträger.* Min. Petr. Mitt. (Tschermak), 1936, vol. 47, pp. 328–370, 37 figs.

olished sections of ores examined by the metallographic method w an intimate intergrowth of various minerals. Argentiferous na, zinc-blende, and pyrite contain minute enclosures of pyrarte and tetrahedrite. A 'Weissgiltigerz' containing Ag 4–6 % acing Pb is identified with jamesonite. L. J. S.

CHER (Albert). *Die Entstehung der Passauer Graphitlagerstätten.* Chemie der Erde, 1936, vol. 10, pp. 539–565, 1 fig.

he presence of vanadium, up to 0·1 % (together with Ni, Co, Cu, s taken to indicate that the graphite is of organic, probably algal, in (like the bitumen of the Black Sea), with subsequent profound ification by metamorphic processes. L. J. S.

Palmqvist (Sven). *Geochemical studies on the iron-bearing Liass series of southern Sweden.* Meddel. Lunds Geol.-Min. Inst., 193 no. 60, 204 pp., 8 pls.; Dissertation, Lund, 1935.

A narrow band of sandy oolitic iron-ores extends for 40 k between Chalk and Silurian in SE. Scania. Sixty detailed chemic analyses are given of material from surface exposures and from dri cores, and these are interpreted as mixtures of chalybite, calcite, san clay, and an undetermined iron silicate. Spectroscopic analy shows the presence of boron (B_2O_3 0·01–0·1 %, suggesting a mari origin), Ge, V, Zn, &c. The origin of the ores is discussed in detai they are probably marine chemical precipitations. L. J. S.

Kato (Takeo). *The alaskitic gold vein of the Kinsei mine, Kor* Japanese Journ. Geol. Geogr., 1936, vol. 13, pp. 103–105, 1

A composite dike consists of earlier pegmatite, then alaskite (c sisting of granular quartz with spots of felspar), and finally ve quartz. The alaskite ore contains 10 grams per ton up to a few cent. of gold, whilst the vein-quartz contains only traces. L. J. S.

Ramdohr (Paul). *Ein Zinnvorkommen im Marmor bei Arandis, Deuts Südwestafrika.* Neues Jahrb. Min., Abt. A, 1935, Beil.-Bd. pp. 1–48, 5 pls., 4 text-figs.

The Stiepelmann mine, 35 km. north of Arandis [M.A. **4**–4 shows a number of pipe-like deposits of cassiterite with pyrrhot and other sulphides in coarse-grained marble near granite and inva by pegmatite. They are mainly of contact-pneumatolytic ori grading into later hydrothermal. More than sixty minerals h been found here, including arandisite [M.A. **4**–248], nordenskiöld [M.A. **6**–64, 184], herzenbergite [M.A. **6**–261–2], stannite, tourmal scapolite, danburite, scheelite, fluorite, &c. Several undetermi minerals (one of them perhaps SnS_2) and a variety of sphene (Zi titanit) containing Sn 10 % are mentioned. L. J. S.

Brown (John S.). *Supergene sphalerite, galena and willemite Balmat, N.Y.* Econ. Geol., 1936, vol. 31, pp. 331–354, 2 fi

The ores at this locality in the Edwards district, St. Lawrence occur in limestone with large solution cavities and an interbed band of pyritic gneiss. Secondary blende and galena are believe have been redeposited by surface waters. Other secondary mine are chlorite (from tremolite), haematite, magnetite, ilvaite, willemite. Ilvaite as small bright crystals gave SiO_2 29·00, A 0·17, Fe_2O_3 17·98, FeO 31·42, MnO 3·96, MgO 1·77, CaO 13·78,

1·49 = 99·57. Willemite occurs in large amount but inconspicuously as small (0·2–0·5 mm.) crystals and grains in a talcy chlorite rock. L. J. S.

Blondel (F.) & Bondon (J.). *Le manganèse de la région du Siroua (Sud marocain)*. Compt. Rend. Acad. Sci. Paris, 1936, vol. 202, pp. 958–959.

Manganese ores occur in a radius of about 25–30 km. around Jebel Siroua, some 120 km. SSE. of Marrakesh. They are of Cambrian and Cretaceous ages. The older occur in lavas and conglomerates. The younger appear to have resulted from lateritic concentration, a mode of origin which appears scarcely consistent with the presence therein of lead in the form of coronadite. C. A. S.

Blondel (F.) & Bondon (J.). *La minéralisation du Précambrien de l'Anti-Atlas*. Compt. Rend. Acad. Sci. Paris, 1936, vol. 202, pp. 673–674.

The Co, Ni, Cr, Cu, and Au of the pre-Cambrian at Bou Azzar and Graara (Anti-Atlas, Morocco) occur in serpentine (altered ankaramite) at its contact with older quartz-gabbro, in vertical veins in which the gangue consists of calcite, dolomite, and quartz, the last of which is clearly older than the dolomitization and mineralization of the serpentine. The Au is confined to deposits associated with the quartz, whether unchanged or dolomitized, and arrived before, and independently of, the Co, &c., the association with which is purely accidental. C. A. S.

Cmelianoff (Georges). *Sur les bauxites de la Lika (Yougoslavie)*. Compt. Rend. Acad. Sci. Paris, 1935, vol. 201, pp. 1405–1407.

The bauxite deposits in the valley of the Lika, east of the Velebit range, form 'pockets of decalcification' around a dome, the nucleus of which consists of Triassic beds. They are probably the oldest in the Balkan peninsula. [Cf. M.A. **6**–232.] C. A. S.

Cooper (W. G. G.). *The bauxite deposits of the Gold Coast*. Bull. Geol. Surv. Gold Coast, 1936, no. 7, 35 pp., 10 pls., 2 text-figs. Price 3*s*. [Cf. M.A. **3**–128.]

—— *Gold Coast bauxite*. Bull. Imp. Inst. London, 1936, vol. 34, pp. 331–347.

These bauxites are mainly gibbsitic. They correspond with a high-vel laterite, and have been derived by the removal of silica from

slaty rocks, including phyllites, lavas, and ashes. The several deposits are described in detail and many chemical analyses are given.

L. J. S.

Clays.

[Zemyatchensky (P. A.)] Земятченский (П. А.). Глины СССР, Общая часть. [*The clays of USSR, General part.*] Петр. СССР под ред акад. Ф. Ю. Левинсон-Лессинга. Сер. II, Монографии. Вып. I Петр. Инст. Акад. Наук СССР (The petrography of USSR edited by F. Y. Loewinson-Lessing, ser. II, Monographs, no. 1 Petrogr. Inst. Acad. Sci. USSR), Moscow-Leningrad, 1935, 359 pp., 55 figs.

This is apparently an introductory volume to the description o clays of USSR and it deals principally with the physical and chemica properties of clays and the methods of testing and analysis. Like th majority of works of this kind it is mainly a compilation of variou methods and theories with a certain amount of critical discussion Although the list of references contains over four hundred items certain recent contributions to the study of clays and clay mineral are not included, and the list contains many incomplete entries an misprints, such as item 326, ' Hotchings. Geol. Magaz., 1896 ', whic apparently refers to one of the papers by W. M. Hutchings.

S. I. T.

[Ginsberg (A. S.) & Nikogosyan (Khr. S.)] Гинзберг (А. С.) Никогосян (Х. С.). Об изменениях в аллофаноидных глинах пр нагревании.—Ginsberg (A.) und Nikogosian (Chr.). *Veränd rungen der allophanoiden Tone bei Erhitzung.* Труд. Мин. Му Акад. Наук СССР (Trav. Musée Min. Acad. Sci. URSS), 192 vol. 4, pp. 221–245, 4 figs. (Russian with German summary.)

Five samples of allophanoid clays (i.e. clays easily decomposed b HCl) associated with a gossan near Potiekhino, Enisey Govt., Siberi were subjected to a chemical and thermal study. The followir varieties were analysed:

	SiO_2.	Al_2O_3.	Fe_2O_3.	CaO.	H_2O+.	H_2O-.	Tota
I. Bluish ...	41·14	35·60	0·81	0·28	8·15	13·33	99·
II. White ...	39·17	34·37	0·87	0·70	11·42	12·60	99·
III. Green ...	24·63	34·04	0·78	2·57	25·63	12·61	100·
IV. Orange ...	37·01	36·89	3·14	0·69	8·96	12·62	99·
V. Black ...	24·10	36·00	0·23	3·17	23·32	12·09	100·

V, also MgO 0·32, Na_2O 0·57, K_2O 0·64.

The heating curves of the first four samples show the following breaks n C°): I, 112°, 308°, 502°, 996°; II, 100°, 167°, 975°; III, 82°, 326°, 42°, 940°; IV, 82°, 234°, 642°, 886°. The breaks below 800° are terraces nd above 800° humps. The dehydration curves for these clays, in con- ast with that of kaolinite, show a more or less gradual fall with the sing temperature. The complete dehydration takes place between 00° (black variety) and 600° (white variety). The white variety lso shows a terrace similar to that of kaolinite between 100° and 00°. The study of the solubility of the products of heating suggests at near 600° an endothermal product—metakaolinite ($Al_2Si_2O_7$)— formed. At about 1000° metakaolinite is decomposed into free iO_2 and Al_2O_3, which at a much higher temperature recombine to rm mullite. S. I. T.

WELL (Raymond H.) & INSLEY (Herbert). *Hydrothermal synthesis of kaolinite, dickite, beidellite, and nontronite.* Journ. Research National Bureau Standards [U.S.A.], 1935, vol. 15, pp. 173–186, 3 pls.

By heating co-precipitated Al_2O_3–SiO_2 gels with water under essure at 310° C. kaolinite was synthesized; at 345–365° C. dickite as obtained, and at 350–390° C. beidellite. Beidellite was also tained from kaolinite at 390° C., and from γ-alumina or boehmite ith silica-glass or gel at 350–390° C. At 350° C. γ-alumina is nverted to boehmite, which is stable; silica gel crystallized as istobalite, silica glass remained unchanged. Small amounts of da present in the gels are responsible for reaction except possibly hen co-precipitated gels are used. A mixed Fe_2O_3–SiO_2 gel at 0–350° C. gave a mixture of haematite and nontronite. Optical id X-ray powder data are given for the various preparations. ndalusite, kyanite, fibrolite, mullite, pyrophyllite, and orthoclase derwent no change when heated with water at 350° C. for ten days. M. H. H.

RRENS (Carl W.) & MEHMEL (M.). *Über den optischen und röntgenographischen Nachweis von Kaolinit, Halloysit und Montmorillonit.* Zeits. Krist., 1936, vol. 94, pp. 337–348, 3 figs.

The close similarity in optical properties and structure of the olin, halloysite, and montmorillonite found in clay and deep-sea ze makes their discrimination by optical and X-ray methods a atter of great difficulty. But the authors show that they can be stinguished by such methods, if due care is taken. H. H.

Roborgh (R. H. J.) & Kolkmeijer (N. H.). *Über die Struktur des Adsorptionskomplexes der Tone.* Zeits. Krist., 1936, vol. 94, pp. 74–79.

The rate of base-exchange of the clay minerals present in soils is considerably greater than the rates observed for zeolites and permutites. This property of clay minerals is considered to be inherent in a thin colloidal layer of a secondary product formed by weathering. X-ray photographs of soil samples (*a*) treated with HCl, (*b*) digested with alkaline calcium acetate in a ball-mill, (*c*) dried in vacuo, in order to vary the amount of colloidal matter, support this view and the authors hope to obtain further data by electron diffraction methods. F. A. B.

Kerr (Paul F.) & Cameron (Eugene N.). *Fuller's earth of bentonitic origin from Tehachapi, California.* Amer. Min., 1936, vol. 21, pp. 230–237, 5 figs.

A bed 8 feet thick of clay in Kern County is interbedded between tuffaceous calcareous shales, over which are andesitic ash and porphyritic hornblende-andesite. The clay is white or light greyish and does not swell in water. It is used for decolorizing petroleum. It consists mainly of flakes of montmorillonite (γ 1·506, $\gamma - \alpha$ 0·02, 2V moderate, negative) together with a zeolitic mineral (n 1·475) 'clinoptilolite' or heulandite [Min. Mag. **23**–556]. X-ray photographs show the patterns of montmorillonite and heulandite. Analysis gave SiO_2 53·88, TiO_2 0·44, Al_2O_3 11·66, $FeO + Fe_2O_3$ 4·60, MnO 0·18, MgO 8·61, CaO 1·56, Na_2O 0·15, K_2O 0·39, P_2O_5 0·16, $H_2O + 110°$ 9·98, $H_2O -$ 8·21 = 99·82. Shard-like structures are rarely seen in the clay but they are abundant in the tuffaceous shales, indicating that the clay has been derived from volcanic ash; and the zeolitic mineral perhaps represents an intermediate stage in the formation of montmorillonite. L. J. S.

Foshag (W. F.) & Woodford (A. O.). *Bentonitic magnesian clay mineral from California.* Amer. Min., 1936, vol. 21, pp. 238–244, 2 figs.

Light-coloured clays interbedded with sand and volcanic tuff occur near Hector in San Bernardino Co. They swell in water yielding a firm jelly. The minute flakes have a basal cleavage, γ 1·500–1·52, $\gamma - \alpha$ 0·02. Relic structures of pumice shards are seen, and the clay probably represents a much altered dacite tuff. X-ray patterns resemble those of saponite. Analysis, SiO_2 53·68, Al_2O_3 0·60, Mg

5·34, CaO 0·52, Na_2O 3·00, K_2O 0·07, Li_2O 1·12, H_2O+ 8·24, $_2O-$ 7·28, Cl 0·31 = 100·16, corresponds with $7MgO.10SiO_2.$ H_2O (neglecting the notable amount of Li_2O and other alkalis); nother analysis corresponds with $2MgO.3SiO_2.3H_2O$. Similar clays re found in other parts of the Mojave Desert in California, and so in Nevada. L. J. S.

ARR (W. A.) & KELLER (W. D.). *Dickite in Missouri.* Amer. Min., 1936, vol. 21, pp. 109–114, 4 figs.

LLEN (Victor T.). *Dickite from St. Louis County, Missouri.* Ibid., pp. 457–459, 2 figs.

Dickite (determined by its optical characters and X-ray pattern) curs as a crystalline powder in cavities in chert nodules and re-acing fossils in limestone near Columbia, and is usually associated ith small amounts of sulphide minerals. It is also found in cavities marcasite in the lead ores at Flat River. A hydrothermal origin suggested. L. J. S.

ARSHALL (C. E.). *The importance of the lattice structure of the clays for the study of soils.* Journ. Soc. Chem. Ind., 1935, vol. 54, pp. 393T–398T., 1 fig.

A review and amplification of previous work. It is emphasized at the $SiO_2 : R_2O_3$ ratio does not afford an adequate characterization soil clays. [Cf. M.A. **6**–235]. M. H. H.

PPARENT (Jacques de). *Les hydroxydes d'aluminium des argiles bauxitiques de l'Ayrshire (Écosse).* Bull. Soc. Franç. Min., 1935, vol. 58, pp. 246–267, 1 pl. [Cf. M.A. **6**–135.]

— *Boehmite and diaspore in the bauxitic clays of Ayrshire.* Sum. Progr. Geol. Surv. Great Britain, for 1934, pt. 2, 1936, pp. 1–7, 1 pl.

A chemical analysis and microscopic study of bauxitic clay from bbs quarry, Kilwinning, north Ayrshire [M.A. **2**–556] shows that olinite and boehmite are the principal constituents with smaller antities of diaspore, ilmenite, goethite, and anatase. Boehmite, served as lozenge-shaped crystals up to 0·06 mm. in length, has an refractive index 1·645 and birefringence 0·013. The forma-n of boehmite and diaspore began as an alumina-silica gel from hydrolysis of silicates in a tropical climate, the presence of humic ters favouring the crystallization of boehmite. With the subsidence he sediments under a covering of Coal Measures and rise of the geotherms the aluminium hydroxide crystallized as diaspore. The olinite was formed at a later date. F. A. B.

Lapparent (Jacques de). *Les milieux générateurs de la montmorillonite et de la sépiolite.* Compt. Rend. Acad. Sci. Paris, 1936, vol. 203, pp. 553–555.

Montmorillonite is the result of the action of magnesian solutions on an unstable alumino-siliceous rock, e.g. on the vitreous portion of a rhyolite. The Mg may in some cases be already in the rock and devitrification merely occur under circumstances such that the Mg is not removed. If it is removed the result is kaolinization. Sepiolite is the result of the action of magnesian solutions on a siliceous gel in presence of calcareous material. C. A. S.

Brajnikov (B.). *Sur le constituant essentiel de l' "argile à silex" de Normandie.* Compt. Rend. Acad. Sci. Paris, 1936, vol. 203, pp. 1595–1597.

The clay (from the chalk of Chapelle St. Ouen, Eure) was boiled with water, dried, and fragments more than 0·25 mm. picked out. The fragments are translucent, chocolate-brown in colour, of nacreous lustre, optically uniaxial, and very soft, ω 1·578, ϵ 1·538, d 2·49. Analysis gave SiO_2 42·7, Al_2O_3 22·7, Fe_2O_3 10·8, CaO 3·5, MgO 1·, K_2O 0·9, with traces of Mn_2O_3 and Na_2O, loss on heating (H_2O, CO and organic matter) 18·7 %. This corresponds with the formula $(Al,Fe)_2O_3.3SiO_2.nH_2O$, or a beidellite with less than normal SiO and falling in Larsen's nontronite-beidellite series [M.A. **3**–451]. X-rays show the structure to be apparently identical with that of nontronite. C. A. S.

Miscellaneous.

Ohashi (Ryōichi). *Heating tests on cristobalite from Kosaka mine, Japan.* (Japanese.) Journ. Geol. Soc. Tokyo, 1936, vol. 4, pp. 453–457.

Octahedral crystals of cristobalite are found in the gas cavities of auganite forming a small dike near the famous 'kuroko' deposit [M.A. **1**–53]. The rock also contains much cristobalite as idiomorphic microphenocrysts, elongated streaks, and mesostasis between the lath-shaped plagioclase of the groundmass. ω 1·489, ϵ 1·482 (Na). The larger (0·5–0·8 mm.) crystals were heated in paraffin under the microscope and the temperatures at which birefringence disappeared and reappeared were 229–255° on heating and 208–227° on cooling. The change takes place rather gradually and differently in different

ystals. Tridymite from the same locality shows a rapid change at 63° on heating and 130° on cooling, R. O.

OLONY (R. J.) [1870–1936]. *Schiller structure.* Amer. Min., 1935, vol. 20, pp. 828–837, 8 figs.

The term schiller structure has been incorrectly applied to the resence of oriented enclosures in various minerals of gabbros, &c., ven when no iridescence or sheen is shown. The term endoblastic tructure is suggested. L. J. S.

NGEMACH (H.) [1880 ?–1936]. *Sur le couple chalcostibite-emplectite et sur la concordance entre dimensions de la maille élémentaire et paramètres cristallographiques.* Bull. Soc. Franç. Min., 1934, vol. 57, pp. 186–207, 3 figs.

Crystallographic axes previously proposed by the author based on is measurements of crystals of chalcostibite from Rar-el-Anz, Wadi herrat, Morocco, are in agreement with Hofmann's X-ray measure-ents [M.A. **2**–185 ; **3**–555 ; **5**–311, 384]. A detailed discussion of roneous axial ratios corrected by X-ray measurements follows.

F. A. B.

KLOV (Alexandr). *Rhodonit z Morašic (Železné hory).* [Rhodonite from Morašice, Iron Mountains.] Časopis Národního Musea, Praha, 1935, vol. 109, pp. 5–7.

Rhodonite from the deposit of manganese ore at Morašice near hvaletice, Bohemia, gave SiO_2 45·61, TiO_2 trace, Al_2O_3 0·08, Fe_2O_3 2, FeO 3·01, MnO 40·37, MgO 1·82, CaO 7·19, H_2O+ 0·24, H_2O- 11 = 100·25. Sp. gr. 3·545, α 1·715, β 1·720, γ 1·729, 2V about 69°. F. S.

EKANINA (Josef). *Nález brushitu na kostech ze Starého Bítova na Vranovské přehradě.* [A find of brushite on bones from Starý Bítov near the river dam of Vranov, Moravia.] Spisy vydávané přírodovědeckou fakultou Masarykovy University (Publ. Fac. Sci. Univ. Masaryk), Brno, 1935, no. 220, 10 pp., 6 figs., with French résumé.

Bones, probably of the 12–13th century, are impregnated and crusted with crystals of brushite. These are tabular on (010) th narrow faces of (310), (011), and (341). Sp. gr. 2·328. $Bx_a = \gamma = b$, $a = 16°$, $a : c = 10\frac{1}{2}°$, α 1·542, β 1·548, 2V 87°. The dehydration rve, determined by R. Nováček, agrees with that of the brushite

from the Domica cave, Slovakia [M.A. **6**–138], and with the formula $CaHPO_4.2H_2O$. F. S.

Zombory (László). *Egy természetes szulfát-gél Vashegyről.*—Zombory (L.v.). *Über ein natürliches Mineralgel von Vashegy.* Földtan Közlöny, Budapest, 1933, vol. 63, pp. 219–220. (Hungarian with German summary.)

Zombory (L. v.). *Über ein natürliches Sulfatgel von Vashegy.* Centr Min., Abt. A, 1934, pp. 90–91.

A dark brown gel when collected was a thick syrupy liquid oozin from a weathered clay-slate. It changed to a jelly, and on exposur to the air it soon hardened. Dried at 105° C. it gave SO_3 37·89 P_2O_5 6·25, SiO_2 2·07, Cl 1·26, Al_2O_3 19·58, Fe_2O_3 11·32, MnO 1·60 CaO 1·68, insol. 0·08, H_2O 18·38 = 100·11. V. Z.

Vavrinecz (Gábor). *Ásványrendszertani tanulmányok. I. Közlemény — Bevezető rész.—A fakóérc csoport.*—Vavrinecz (G.). *Mineralsys tematologische Studien. I. Allgemeines. Die Fahlerzgruppe* Földtani Közlöny, Budapest, 1935, vol. 65, pp. 105–120, 4 pls. c tables. (German with Hungarian summary.)

A definition is given of a mineral and an attempt is made t define the limits of species, sub-species, and varieties. This i applied specially to the fahlerz group. The molecular ratios of 19 fahlerz analyses from the literature are tabulated, and the genera formula deduced as $[R', R''S_4]_3XS_3$. V. Z.

[Alimarin (I. P.)] Алимарин (И. П.). Химический состав чевкинита.— Alimarin (I. P.). *Die chemische Zusammensetzung von Tschewkini* Докл. Акад. Наук СССР (Compt. Rend. Acad. Sci. URSS), 193 vol. 1, pp. 648–651 (Russian), pp. 651–653 (German).

The analysed specimen of tscheffkinite (chevkinite) from Kyshtyı district (Ural Mts.) was in the form of a jet-black pebble, of vitreou lustre, conchoidal fracture, sp. gr. 4·491, H. 5, fus. 4. The analys by M. S. Vezhenkova gave: SiO_2 19·23, TiO_2 19·61, ThO_2 0·7 SnO_2 trace, $(Nb,Ta)_2O_5$ 0·01, Al_2O_3 2·17, Fe_2O_3 2·60, Cr_2O_3 0·0 Ce_2O_3 20·52, $(La,Di)_2O_3$ 18·77, $(Y,Er)_2O_3$ 0·93, FeO 8·75, MnO 1·1 MgO 0·05, CaO 2·49, SrO 0·00, BaO 0·00, BeO trace, Na_2O & K_2 0·10, H_2O+ 0·81, H_2O- 0·03, CO_2 trace, P_2O_5 0·00, S 0·1 Cl 0·00 = 99·13. S. I. T.

Prokopenko (N. M.)] Прокопенко (Н. М.). О находках породообразующих ортитов в горных породах Средней Азии.—Prokopenko (N. M.). *Funde gesteinbildender Orthite in den Felsarten Mittelasiens.* Докл. Акад. Наук СССР (Compt. Rend. Acad. Sci. URSS), 1935, vol. 1, pp. 532–534 (Russian), pp. 534–536 (German).

Orthite (allanite) as an accessory mineral of granites and granite-egmatites is abundant in the region of Tallass-Alatau and other egions of Central Asia. S. I. T.

Tolmachev (Y. M.) & Filippov (A. N.)] Толмачев (Ю. М.) и Филиппов (А. Н.). О нахождении редких щелочных металлов в амазонитах.—Filippov (A.) and Tolmačev (J.). *On the presence of rare alkaline metals in amazonites.* Докл. Акад. Наук СССР (Compt. Rend. Acad. Sci. URSS), 1935, vol. 1, pp. 321–323 (Russian), pp. 323–325 (English).

Nine specimens of amazonite from Ilmen Mts., Khibina tundra, olorado, and Madagascar were spectroscopically analysed for rare kalis. The amazonites of Ilmen Mts. are particularly rich in Rb verage over 1 %) and also contain Cs (average 0·5 %), besides small uantities of Ga, Be, and Sr. The bluish-green colour of the amazon-es can hardly be attributed to copper, the content of which in all e specimens investigated did not exceed 0·001 %. The formula of mazonite, as formerly suggested by V. I. Vernadsky, should be $(K,Rb,Na)_2Al_2Si_6O_{16}$. S. I. T.

utzeit (G.) & Galopin (R.). *Différenciation chimique, par la méthode à la touche, de quelques sulfosels voisins en surface polie.* Compt. Rend. Soc. Physique Hist. Nat. Genève, 1934, vol. 51, pp. 53–61.

enger (P.), Gutzeit (G.), & Hiller (Th.). *Sur un procédé d'attaque électrolytique des minéraux opaques, et sur son application à la technique des "empreintes" de surfaces polies.* Ibid. pp. 64–67.

ller (Th.). *Contribution à l'étude des minéraux opaques par la méthode des empreintes. Perfectionnements apportés à la technique d'attaque électrolytique.* Ibid., 1935, vol. 52, pp. 119–122.

ller (Th.). *Sur la détermination de quelques linnéites de la Rhodésie du Nord et du Katanga par la méthode des empreintes.* Ibid., pp. 122–125, 1 pl.

By applying a sheet of gelatine-coated paper soaked with a suitable d to a polished surface of a mineral, and developing the sheet with uitable reagent, colour reactions for the various elements present y be obtained. Further, in the case of intergrowths, the several

minerals present are readily distinguished. The method is applie principally to sulphides and arsenides. A method of electrolyti attack is also described, and is often preferable to acid. The identi fication of linnaeite in a number of specimens by this method i described. A linnaeite from N'Kana, Northern Rhodesia, gav Co 42·59, Cu 9·30, Fe 5·00, Ni nil, S 43·60, total 100·49.

M. H. H.

Nieuwenburg (C. J. van) & Zon (*Miss* P. M. van). *Semi-quantita tive measurements of the solubility of quartz in super-critic steam.* Rec. Trav. Chim. Pays-Bas, 1935, vol. 54, pp. 129–13 1 fig.

Approximate figures are given for the solubility of quartz in supe critical steam at 380°, 400°, and 425° C. and 300–500 atmospher pressure. The solubility increases with pressure and decreases wit rise of temperature. Special experiments were made showing th the errors pointed out by G. W. Morey [M.A. **5**–257] cannot wholl explain the observations. The solubilities found are of the order 0·02 to 0·08 % by weight. [Cf. M.A. **5**–102, 256, 446 ; **6**–192.]

M. H. H.

Hámos (L. v.). *Microchemical analysis of plane polished surfaces means of monochromatic X-ray images.* Nature, London, 193 vol. 134, pp. 181–182, 3 figs.

The surface of an ore specimen is irradiated with X-rays and t secondary radiation is resolved into a series of monochromatic bear by means of a crystal of sodium chloride curved to a cylindric surface. Each of the images formed on a photographic plate suitab placed near the sodium chloride is due to a chemical element a shows the distribution of this element over the surface of the o specimen. The resolving power of the method is about 0·1 m but can probably be increased by improved technique. F. A. B.

Walker (T. L.). *A study of the mineral composition of mine du* Univ. Toronto Studies, Geol. Ser., 1935, no. 38, pp. 5–11.

The determination of the proportions of different minerals prese in very fine (3 μ) dust is difficult. The methods of treating with H and fluosilicic acid (to remove carbonates and silicates, leaving residue of quartz) and micrometric analysis are only approxima Analyses of the rock of the Lake Shore mine, Ontario, and of t resulting dust indicate that the latter is richer in carbonates a

muscovite and poorer in quartz. An X-ray method is mentioned [M.A. **6**–329]. L. J. S.

WALKER (T. L.). *An unusual type of quartz.* Univ. Toronto Studies, Geol. Ser., 1935, no. 38, pp. 31–32, 1 fig.

Milky-white translucent quartz (sp. gr. 2·63) from a gold mine in the Okanagan district, British Columbia, shows large (several square feet) cleavage surfaces marked by parallel rulings, much resembling plagioclase felspar. The angle between the cleavages is approximately the rhombohedral angle *rr*, and the cleavage appears to be a parting due to twinning on *r*. Liquid (aqueous) inclusions with a bubble are abundant, and some show a rapidly moving black particle. L. J. S.

LARSONS (A. L.). *Trisoctahedral garnet from West Thetford Mines, P.Q.* Univ. Toronto Studies, Geol. Ser., 1935, no. 38, pp. 33–36.

Crystals of garnet with diopside in a clayey matrix are pale goose-berry-green and isotropic in the outer portion, but rather darker and anisotropic inside. Analysis by W. F. Green gave SiO_2 36·66, TiO_2 0·10, Al_2O_3 4·18, Fe_2O_3 24·86, MnO 0·20, MgO 0·25, CaO 33·89, ign. 0·06 = 100·20, sp. gr. 3·356, corresponding with andradite 78·74, grossular 18·45, and diopside 2·91 %. The predominating form is {332}, with also (110), (211). The relation of this rarer form to the crystal-structure of garnet is discussed. L. J. S.

LARSONS (A. L.). *Linear mineralogical arithmetic.* Amer. Min., 1935, vol. 20, pp. 388–392, 2 figs.

A graph of molecular weights, molecular proportions, and percentages is used for calculating molecular proportions and the mineral composition of rocks. Another graph gives the composition of mixtures from the specific gravity. L. J. S.

DOUGH (Frederick H.). *Phenakit, seine Morphologie und Paragenesis.* Neues Jahrb. Min., Abt. A, 1936, Beil.-Bd. 71, pp. 291–341, 9 pls., 10 text-figs. [Cf. M.A. **6**–288].

A detailed discussion of the crystal-forms of phenakite; 35 certain (including 8 new) and 12 doubtful forms are listed. Light-figures and the surface markings of growth and corrosion on the faces are described. No twins were found amongst the material examined. The mineral occurs in pegmatites with beryl and in hydrothermal veins. L. J. S.

Thibault (Newman W.). *The crystallography of a phenacite from Amelia Court House, Virginia.* Bull. Virginia Polytechnic Institute, Blacksburg, Va., 1936, vol. 29, no. 3, 10 pp., 1 fig.

Measurements are given of a well-developed crystal of phenakite from the Morefield mine [M.A. **6**–215, 288], of flat rhombohedral habit and showing sixteen crystal-forms, including the new negative left-handed rhombohedron y, $(15\bar{6}5)$; $a:c = 1:0{\cdot}6612$. L. J. S.

Schaller (Waldemar T.). *Monticellite from San Bernardino County, California, and the monticellite series.* Amer. Min., 1935, vol. 20, pp. 815–827.

Greenish grains of monticellite from metamorphic dolomite from the Dewey mine gave SiO_2 37·36, FeO 1·40, MnO 0·04, MgO 24·90, CaO 33·08, H_2O+ 1·24, H_2O- 0·04, insol. (diopside) 2·55 = 100·61. α 1·641, β 1·649, γ 1·655. The refractive indices of pure $MgCaSiO_4$ (monticellite) and $MnCaSiO_4$ (glaucochroite) are calculated and compared with those of the artificial compound $FeCaSiO_4$.

L. J. S.

Palache (Charles). *Additional notes on pseudobrookite.* Amer. Min. 1935, vol. 20, pp. 660–663, 3 figs. [Cf. M.A. **5**–522.]

Further specimens in lithophysal rhyolite from Thomas Range near Joy, Juab Co., Utah, show acicular crystals up to 2½ cm. long with the new forms x (021), w (25$\bar{2}$), and v (14$\bar{1}$). Analysis by F. A. Gonyer, TiO_2 38·12, Fe_2O_3 60·57, MgO 1·26 = 99·95, shows an approximation to the theoretical formula Fe_2TiO_6, but with an excess of 4·76 % TiO_2, probably due to admixed rutile. Crystals from shonkinite at Katzenbuckel, Baden, showed eight crystal-forms including r (212). This last, together with t (412), had been previously noted by P. Ramdohr (1923) on crystals from basalt at Hessenbrücker Hammers, Hesse. [$a:b:c = 0{\cdot}9777:1:0{\cdot}3727$.]

L. J. S.

Guild (F. N.). *Piedmontite in Arizona.* Amer. Min., 1935, vol. 20, pp. 679–692, 12 figs. [Cf. M.A. **3**–456.]

Spots and veins of piedmontite are present in felsitic rhyolite in the Santa Rita Mts. and the Tucson Mts., and the mineral also occurs in quartz veins extending from the felsites into the adjacent sandstones. Analysis by P. H. Brinton of piedmontite from Tucson Mts. gave SiO_2 37·43, TiO_2 0·10, Al_2O_3 21·27, Fe_2O_3 3·80, Mn_2O_3 11·80

gO nil, CaO 24·75, $H_2O+110°$ 0·92, $H_2O-110°$ 0·04 = 100·11; 1·732 buff, β 1·750 deep vinaceous lavender, γ 1·778 spinel-pink. aunite is also present. The rhyolite and the sandstone contain n_2O_3 (0·05–0·2 %). L. J. S.

MONSON (Russell R.). *Piedmontite from Los Angeles County, California.* Amer. Min., 1935, vol. 20, pp. 737–738.

Small crystals of piedmontite occur in metamorphic sedimentary cks (quartz-sericite-biotite-schist and quartzite) near a quartz-orite dike near the junction of Bouquet and Texas canyons. Pleo-roism, a orange to lemon-yellow, β amethystine red, γ carmine; tinction $a:c = -3°$. L. J. S.

LIAFERRO (N. L.). *Some properties of opal.* Amer. Journ. Sci., 1935, ser. 5, vol. 30, pp. 450–474, 9 figs.

Values of the specific gravity and refractive index for a number opals and opaline cherts, mainly from California, show ranges ·983–2·111, n 1·441–1·456, H_2O 4·75–8·70 %. But they show no gular variation with H_2O; when plotted against H_2O they lie ttered between theoretical curves for silica-glass + water and stobalite + water. On slow dehydration at 120–350° C. there is an increase in d and n up to a transition point (1·6–2·8 mols. H_2O), er which they decrease; and in the completely dehydrated material and n are less than in the original material. X-ray powder otographs show faint patterns of high-temperature β-cristobalite, t no actual crystals are present. [Cf. M.A. **4**–517; **5**–382, 470; 54.] L. J. S.

TO (Helmut). *Die Rolle des Mangans in den Mineralien.* Min. Petr. Mitt. (Tschermak), 1935, vol. 47, pp. 89–140, 13 figs.

— *Der Einfluß des Mangans auf die Optik der Mineralien.* Fortschr. Min. Krist. Petr., 1936, vol. 20, pp. 55–56.

Thirteen new chemical analyses with optical data and sp. gr. are en of various manganese-bearing minerals (triplite, triphyline, ldrenite, spessartine, troostite manganapatite, bustamite, pied-ntite, and carpholite), and the results are plotted, together with a from the literature, showing a decrease in refractive index h isomorphous replacement of Fe″ by Mn″, and an increase h replacement of Zn, Mg, Ca, Li by Mn″ and of Al by Mn‴. The ied coloration (pink, yellow, brown, green, violet) of manganese

minerals, and the occurrence of manganese in rocks of different kind are discussed. L. J. S.

Kindle (E. M.). *Manganese concretions in Nova Scotia lakes.* Trans Roy. Soc. Canada, 1935, ser. 3, vol. 29, sect. 4, pp. 163–180, 1 p

The nodular or more often disk or saucer-shaped concretions (3– inches across) are formed around pebbles on the bottom of the lake and contain MnO_2 35·29, Fe_2O_3 16·56 %. They have probably bee formed by the action of algae extracting manganese and iron fro the lake water. [Cf. M.A. **4**–406.] L. J. S.

Donnay (J. D. H.) & Mélon (J.). *Faciès remarquable de cristaux pyrite.* Bull. Soc. Géol. Belgique, 1935, vol. 59, pp. B 29–B 3 1 fig.

A crystal of pyrite, probably from Belgium, shows an equ development of (210) and (311) as the predominating forms, wit small (100), (10.5.1), and (111). The faces of the rare form (311) a striated parallel to the edge [311, 100], and those of (210) parall to [210, 100]. The crystal is a bad conductor of electricity; wh placed in a circuit with a lamp and a 4-volt battery the lamp is n illuminated, while with other crystals striated perpendicular to t cube edges the current passes. L. J. S.

Kleber (Willi) & Schroeder (Robert). *Über die morphologisch und strukturellen Verhältnisse des Kuprit.* Neues Jahrb. Mi Abt. A, 1935, Beil.-Bd. 69, pp. 364–387, 8 figs.

Twenty crystal-forms are listed and discussed, including the pe tagonal icositetrahedra *D* (542), *z* (13.12.10), *Z* (986), and *E* (764 The plagihedral hemihedrism is not shown by etch-figures or X-ray methods and the crystals show no rotatory polarization. T space-group is given as O^2, and the lack of agreement is attributed a slight distortion of the Cu-tetrahedra. L. J. S.

Morrison (Roger B.). *The occurrence and origin of celestite a fluorite at Clay Center, Ohio.* Amer. Min., 1935, vol. 20, p 780–790, 4 figs.

Celestine as pale blue to white crystals associated with bro fluorite and calcite forms lenticular masses in cellular dolomi rock of the Niagara group. The colour and yellow fluorescence the fluorite are due to enclosed bituminous matter. These miner have been deposited by meteoric waters, which have leached t materials from the surrounding rocks. L. J. S.

RAHAM (William A. P.) [–1934]. *An occurrence of narsarsukite in Montana.* Amer. Min., 1935, vol. 20, pp. 598–601.

A yellow mineral in quartz veins in syenite at Sweet Grass Hills ve an analysis by R. B. Ellestad, SiO_2 62·30, TiO_2 16·80, Al_2O_3 0·32, $_2O_3$ and FeO 3·46, MgO 0·46, CaO 0·18, Na_2O 15·31, K_2O 0·41 = ·24. It is tetragonal with good prismatic cleavage; sp. gr. 2·75, 5½, ω 1·612, ϵ 1·653; pleochroism, ϵ honey-yellow, ω colourless. oth this and the original narsarsukite from Greenland show some riation in the optical data. L. J. S.

ORTHROP (Stuart A.). *Thulite from New Mexico.* Amer. Min., 1935, vol. 20, pp. 805–807; correction, ibid., 1936, vol. 21, p. 73.

Rose-red thulite occurs in a quartz vein and in the adjacent mica-ist near pegmatite at Pilar in Taos County. Analysis by S. B. ppincott of material containing some quartz gave SiO_2 49·19, $_2O_3$ 24·26, Fe_2O_3 3·38, MnO_2 1·62, CaO 19·90, H_2O 1·39 = 99·74; gr. 3·15. L. J. S.

NSOME (Alfred L.). *Enargite and plumbojarosite at Picher, Oklahoma.* Amer. Min., 1935, vol. 20, pp. 799–805, 1 fig.

A single specimen (8½ × 5 × 3 inches) from a cave in the Barr mine ows, on a matrix of brecciated chert, blende, chalcopyrite, calcite, psum, enargite, marcasite, covelline, sulphur, quartz, dolomite, ena, anglesite, and plumbojarosite. This is the first record of mbojarosite and the second for enargite [M.A. **6**–144] from the d-zinc deposits of the Tri-State district. L. J. S.

OSDOFF (M.) & TRUOG (E.). *A method for removing iron oxide coating from minerals.* Amer. Min., 1935, vol. 20, pp. 669–673.

The iron oxide film on grains of sedimentary materials is removed treating with H_2S in water suspension, and dissolving in dilute l the sulphide so formed. L. J. S.

UNZ (H.). *Strukturelle und morphologische Beziehungen zwischen Epidot und Zoisit und zwischen Epidot und Ardennit.* Zeits. Krist., 1935, vol. 92, pp. 402–407, 2 figs.

By a suitable choice of crystallographic axes it is possible to bring similarities in the structure of epidote, zoisite, and ardennite. H. H.

Ahlfeld (Friedrich), Himmel (Hans), & Kleber (Willi). *Beitr zur Kenntnis bolivianischer Mineralien. V. Franckeit.* Zen Min., Abt. A, 1935, pp. 292–298, 6 figs. [Cf. M.A. **6**–189.]

Franckeite from Porvenir mine, Huanuni, forms confused agg gates of minute, thin-lamellar, very plastic crystals, with perf cleavage parallel to the large surface and a number of small faces the edges. They are orthorhombic (pseudo-tetragonal) with

$a : b : c = 1{\cdot}051 : 1 : 1{\cdot}808$. L. J. S.

Kleber (Willi). *Über Phosphophyllit.* Neues Jahrb. Min., Abt. 1935, Beil.-Bd. 70, pp. 203–218, 1 pl., 10 text-figs.

Crystals of phosphophyllite from Hagendorf, Bavaria, are describ and m ($\bar{3}04$) added to the list of crystal-forms [axes of Palache a Berman, M.A. **3**–358]. Sp. gr. 3·081, α 1·595, β 1·614, γ 1·6 $\gamma : c = +50°$. Blowpipe tests show the presence of Fe and Mn, a perhaps also Zn. [Cf. M.A. **3**–274.] L. J. S.

Yatsevitch (G. M.). *The crystallography of herderite from Topsha Maine.* Amer. Min., 1935, vol. 20, pp. 426–437, 4 figs.

Herderite crystals from this new locality [M.A. **5**–522] are prisma in the direction of the c-axis with pronounced monoclinic devel ment; some are twinned on (100). They are rich in forms, w new α ($\bar{1}04$), β ($\bar{1}15$) ?, γ (121). The axes of S. L. Penfield (189 but with 3 c, are adopted, viz. $a : b : c = 0{\cdot}6307 : 1 : 1{\cdot}2822$, $\beta = 89° 5$ Optical data: α 1·591, β 1·611, γ 1·619, 2V 75° ± 5°, $\beta =$ $\gamma(\mathrm{Bx}_a) : c = 3\frac{1}{2}°$. Crystals from Greenwood, Maine, are prismatic the direction of the a-axis. The angles in these two prismatic zo are similar and liable to confusion. A table of angles is given for accepted and 11 uncertain crystal-forms for herderite. L. J. S.

Staples (Lloyd W.). *Adamite from Gold Hill, Tooele Co., Ut* Amer. Min., 1935, vol. 20, pp. 371–376, 2 figs.

Pale honey-yellow prisms (‖ b-axis) and small colourless rosette adamite occur in cavities in limonite with quartz, calcite, a austinite [M.A. **6**–53]. Forms d m b h t [Dana's letters],

$a : b : c = 0{\cdot}9742 : 1 : 0{\cdot}7095$; α 1·711, β 1·723, γ 1·756. L. J. S.

Himmel (Hans) & Schroeder (Robert). *Strengit von Pleyst* Zentr. Min., Abt. A, 1935, pp. 289–292.

New measurements gave $a : b : c = 0{\cdot}8647 : 1 : 0{\cdot}9762$. A table forms and angles is given. L. J. S.

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